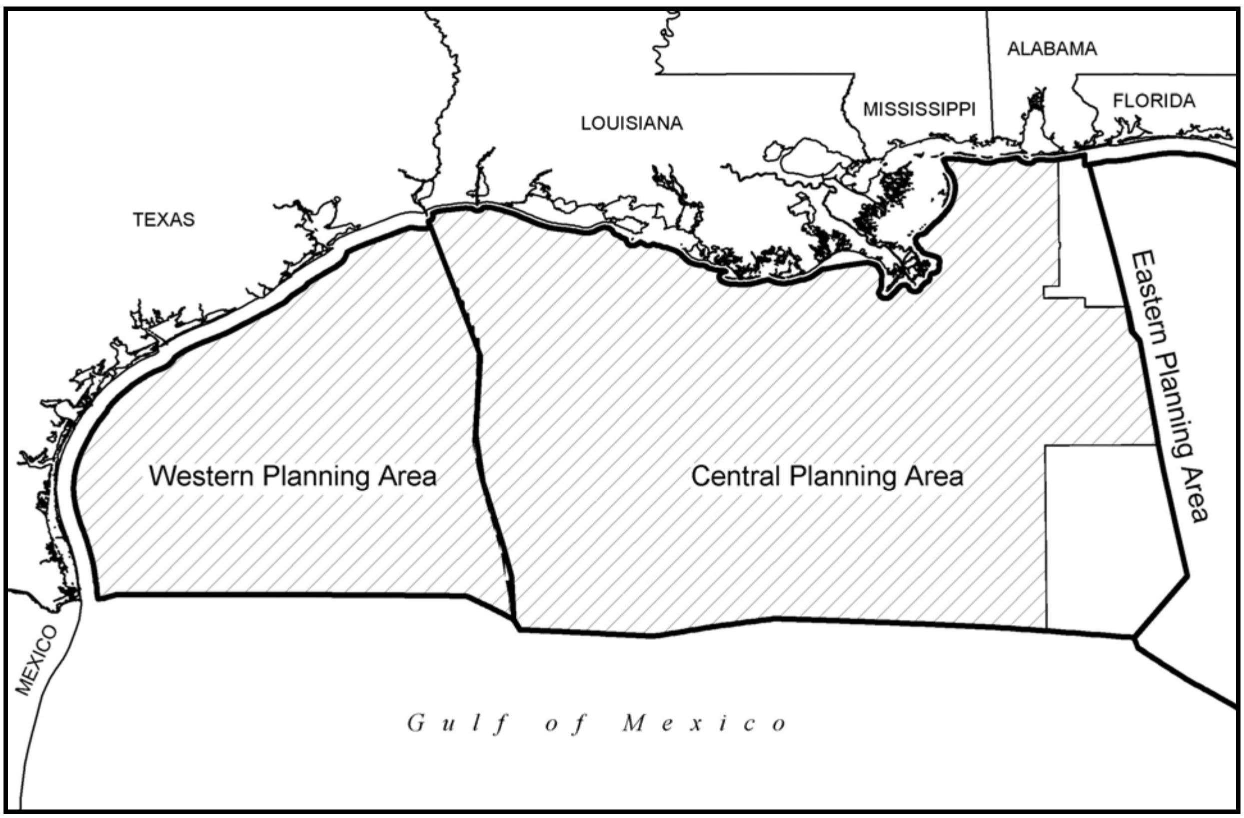
OCS EIS/EA
MMS 2006-062

Gulf of Mexico OCS Oil and Gas Lease Sales: 2007-2012

Western Planning Area Sales 204, 207, 210, 215, and 218
Central Planning Area Sales 205, 206, 208, 213, 216, and 222

Draft Environmental Impact Statement

Volume I: Chapters 1-8 and Appendices



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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REGIONAL DIRECTOR'S NOTE

In the *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012,* five annual areawide lease sales are scheduled for the Western Planning Area and six annual areawide lease sales are scheduled for the Central Planning Area. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since each lease sale proposal and projected activities are very similar each year for each sale area, the Minerals Management Service (MMS) has prepared a single EIS for the 11 Western and Central Gulf sales. At the completion of this EIS process, decisions will be made only for proposed Lease Sale 204 in the WPA and proposed Lease Sale 205 in the CPA. An environmental analysis will be prepared for each subsequent proposed lease sale. By eliminating essentially duplicate EIS's, MMS will be able focus the subsequent environmental reviews on new and changing issues.

The Gulf of Mexico Outer Continental Shelf (OCS) Region of MMS has been conducting environmental analyses of the effects of OCS oil and gas development since the inception of the National Environmental Policy Act (NEPA) of 1969. We have prepared and published more than 40 draft and final EIS's. Our goal has always been to provide factual, reliable, and clear analytical statements in order to inform decisionmakers and the public about the environmental effects of proposed OCS activities and their alternatives. We view the EIS process as providing a balanced forum for early identification, avoidance, and resolution of potential conflicts. It is in this spirit that we welcome comments on this document from all concerned parties.

Chris C. Oynes

Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region

COVER SHEET

Environmental Impact Statement for Proposed Western Gulf of Mexico OCS Oil and Gas Lease Sales 204, 207, 210, 215, and 218, and Proposed Central Gulf of Mexico OCS Oil and Gas Lease Sales 205, 206, 208, 213, 216, and 222

	Draft (x)	**Final ( )**
Type of Action:	Administrative (x)	Legislative ( )
Area of Potential Impact:	Offshore Marine Environment and Coastal Counties/Parishes of Texas, Louisiana, Mississippi, Alabama, and northwestern Florida	

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ABSTRACT

This Draft Environmental Impact Statement (EIS) covers the proposed 2007-2012 Western and Central Gulf of Mexico OCS oil and gas lease sales. The proposed Western Gulf of Mexico lease sales are Sale 204 in 2007, Sale 207 in 2008, Sale 210 in 2009, Sale 215 in 2010, and Sale 218 in 2011; the proposed Central Gulf of Mexico lease sales are Sale 205 in 2007, Sale 206 in 2008, Sale 208 in 2009, Sale 213 in 2010, Sale 216 in 2011, and Sale 222 in 2012. The proposed actions are major Federal actions requiring an EIS. This document provides the following information in accordance with the National Environmental Policy Act and its implementing regulations, and it will be used in making decisions on the proposal. This document includes the purpose and background of the proposed actions, identification of the alternatives, description of the affected environment, and an analysis of the potential environmental impacts of the proposed actions, alternatives, and associated activities, including proposed mitigating measures and their potential effects. Potential contributions to cumulative impacts resulting from activities associated with the proposed actions are also analyzed.

Hypothetical scenarios were developed on the levels of activities, accidental events (such as oil spills), and potential impacts that might result if a proposed action is adopted. Activities and disturbances associated with a proposed action on biological, physical, and socioeconomic resources are considered in the analyses.

Additional copies of this EIS and the referenced MMS publications and visuals may be obtained from the MMS, Gulf of Mexico OCS Region, Public Information Office (MS 5034), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394, or by telephone at 504-736-2519 or 1-800-200-GULF.

SUMMARY

This environmental impact statement (EIS) addresses 11 proposed Federal actions that offer for lease areas on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) that may contain economically recoverable oil and gas resources. Under the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (the proposed 5-Year Program), five annual areawide lease sales are scheduled for the Western Planning Area (WPA) and six annual areawide lease sales are scheduled for the Central Planning Area (CPA). The proposed WPA lease sales are Sale 204 in 2007, Sale 207 in 2008, Sale 210 in 2009, Sale 215 in 2010, and Sale 218 in 2011; the proposed CPA lease sales are Sale 205 in 2007, Sale 206 in 2008, Sale 208 in 2009, Sale 213 in 2010, Sale 216 in 2011, and Sale 222 in 2012. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since each lease sale proposal and projected activities are very similar each year for each sale area, a single EIS is being prepared for the 11 Western and Central Gulf sales. At the completion of this EIS process, decisions will be made only for proposed Lease Sale 204 in the WPA and proposed Lease Sale 205 in the CPA. A National Environmental Policy Act (NEPA) review will be conducted before each subsequent proposed lease sale.

This summary section is only a brief overview of the proposed lease sales, alternatives, significant issues, potential environmental and socioeconomic effects, and proposed mitigating measures contained in this EIS. To obtain the proper perspective and context of the potential environmental and socioeconomic impacts discussed, it is necessary to read the analyses in their entirety. Relavent discussions can be found in the chapters of this EIS as described below. Volume I contains **Chapters 1 through 8** and the **Appendices**, which are listed below, and provides more in-depth information and analyses. Figures and tables are presented separately in Volume II.

- **Chapter 1**, the Proposed Actions, describes the purpose of and need for proposed lease sales. **Chapter 1** also provides summaries of the major, applicable, Federal laws and regulations; and describes the prelease process, postlease activities; and other OCS-related activities.

- **Chapter 2**, Alternatives Including the Proposed Actions, describes the environmental and socioeconomic effects of the proposed lease sales and alternatives. Also discussed are potential mitigation measures to avoid or minimize impacts.

- **Chapter 3**, Description of the Affected Environment, describes the environment that would potentially be affected by the proposed actions or the alternatives. Also described are existing offshore and coastal infrastructure, which supports OCS oil and gas activities. The description of the affected environment includes impacts from recent major hurricanes to the physical environmental, biological environment, and socioeconomic activities and OCS-related infrastructure. This baseline data are considered in the assessment of impacts from the proposed lease sales to these resources and the environment.

- **Chapter 4**, Environmental and Socioeconomic Consequences, describes the scenario and impact-producing factors (IPF's) associated with the proposed lease sales and alternatives, and the potential impacts on the environmental and socioeconomic resources described in **Chapter 3**.

  — **Chapter 4.1**, Impact-Producing Factors and Scenario—Routine Operations, describes the offshore infrastructure and activities (IPF's) associated with the proposed lease sales and with the OCS Program that could potentially affect the biological, physical, and socioeconomic resources of the GOM.

  — **Chapter 4.2**, Environmental and Socioeconomic Impacts of the Proposed Gulf Sales and Alternatives—Routine Events, discusses impacts of routine activities associated with a typical sale in the WPA (Chapter 4.2.1, Alternatives for Proposed Western Gulf Sales 204, 207, 210, 215, and 218) and a typical sale in the CPA (**Chapter 4.2.2,** Alternatives for Proposed Central Gulf Sales 205, 206, 208, 213, 216, and 222).

- **Chapter 4.3**, Impact-Producing Factors and Scenario—Accidental Events, discusses potential accidental events (i.e., oil spills, losses of well control, vessel collisions, and spills of chemicals or drilling fluids) that may occur as a result of a proposed lease sale.
- **Chapter 4.4**, Environmental and Socioeconomic Impacts of the Proposed Gulf Sales and Alternatives—Accidental Events, discusses impacts of potential accidental events that may occur as a result of a proposed lease sale.
- **Chapter 4.5**, Cumulative Environmental and Socioeconomic Impacts, presents a cumulative analysis, which considers environmental and socioeconomic impacts that may result from the incremental impact of the 11 proposed lease sales when added to all past, present, and reasonably foreseeable future human activities, including non-OCS activities, as well as all OCS activities (OCS Program).
- **Chapter 4** also includes **Chapter 4.6**, Unavoidable Adverse Impacts of the Proposed Actions; **Chapter 4.7**, Irreversible and Irretrievable Commitment of Resources; and **Chapter 4.8**, Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity.

- **Chapter 5**, Consultation and Coordination, describes the consultation and coordination activities with Federal, State, and local agencies and other interested parties that occurred during the development of this EIS.
- **Chapter 6**, References, is a list of literature cited throughout this EIS.
- **Chapter 7**, Preparers, is a list of names of persons who were primarily responsible for preparing and reviewing this EIS.
- The **Appendices** contain material prepared in connection with the EIS that support description or analyses in this EIS.

Proposed Actions and Alternatives

Alternatives for Proposed Western Gulf Sales 204, 207, 210, 215, and 218

Alternative A – The Proposed Action(s): This alternative would offer for lease all unleased blocks within the WPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary; and

(2) whole and partial blocks that lie within the 1.4-nautical mile (nmi) buffer zone north of the continental shelf boundary between the U.S. and Mexico for Sales 204, 207, 210, and 215 only.

The WPA encompasses about 28.7 million acres (ac). The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.242-0.423 billion barrels of oil (BBO) and 1.644-2.647 trillion cubic feet (Tcf) of gas.

Alternative B — The Proposed Actions Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the WPA, as described for the proposed actions, with the exception of any unleased blocks subject to the Topographic Features Stipulation.

Alternative C — Use of a Nomination and Tract Selection Leasing System: This alternative would offer for lease for each proposed action a maximum of 300 industry-nominated blocks and offer all blocks that become available for leasing after the industry nomination deadline and before the Final Notice of Sale (FNOS) is published for that proposed action. The same exclusions described under Alternative A would apply. The number of blocks offered would be about 25 percent of the blocks estimated to be offered under an areawide leasing system (Alternative A); it is estimated that this alternative would result in a 25 percent reduction in the number of blocks leased per proposed action.

Alternative D — No Action: This is the cancellation of one or more proposed WPA lease sales. The opportunity for development of the estimated 0.242-0.423 BBO and 1.644-2.647 Tcf of gas that could have resulted from a proposed WPA lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed. This is analyzed in the Draft EIS for the 5-Year Program.

Alternatives for Proposed Central Gulf Sales 205, 206, 208, 213, 216, and 222

Alternative A — The Proposed Actions: This alternative would offer for lease all unleased blocks within the CPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) blocks that were previously included within the Eastern Planning Area (EPA) and that are within 100 mi of the Florida coast;

(2) blocks that were previously included within the EPA and that are under an existing Presidential withdrawal through 2012, as well as subject to annual congressional moratoria;

(3) blocks that are beyond the U.S. Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(4) whole and partial blocks that lie within the 1.4-nmi buffer zone north of the continental shelf boundary between the U.S. and Mexico for Sales 205, 206, 208, and 213 only.

The CPA sale area encompasses about 58.7 million ac of the CPA's 66.3 million ac. The estimated amount of resources projected to be developed as a result of any one proposed CPA lease sale is 0.776-1.292 BBO and 3.236-5.229 Tcf of gas.

Alternative B — The Proposed Actions Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed actions, with the exception of any unleased blocks subject to the Topographic Features Stipulation.

Alternative C — The Proposed Actions Excluding the Unleased Blocks Within 15 Miles of the Baldwin County, Alabama, Coast: This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed actions, with the exception of any unleased blocks within 15 mi of the Baldwin County, Alabama, coast.

Alternative D — Use of a Nomination and Tract Selection Leasing System: This alternative would offer for lease for each proposed action a maximum of 1,000 industry-nominated blocks and offer all blocks that become available for leasing after the industry nomination deadline and before the FNOS is published for that proposed action. The same exclusions described under Alternative A would apply. The number of blocks offered would be about 25 percent of the blocks estimated to be offered under an areawide leasing system (Alternative A); it is estimated that this alternative would result in a 25 percent reduction in the number of blocks leased per proposed action.

Alternative E — No Action: This alternative is the cancellation of one or more proposed CPA lease sales. The opportunity for development of the estimated 0.776-1.292 BBO and 3.236-5.229 Tcf of gas that could have resulted from a proposed CPA lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed. This is analyzed in the Draft EIS for the 5-Year Program.

Mitigating Measures

All of the proposed actions include existing regulations and proposed lease stipulations designed to reduce environmental risks, potential multiple-use conflicts between OCS operations and U.S. Department of Defense activities, and visual impacts from development operations south of Baldwin County, Alabama. Four lease stipulations are proposed for the WPA sales—the Topographic Features Stipulation, the Military Areas Stipulation, the Operations in the Naval Mine Warfare Area Stipulation, and the Protected Species Stipulation. Seven lease stipulations are proposed for the Central Gulf sales—the Topographic Features Stipulation, the Live Bottom Stipulation, the Military Areas Stipulation, the Evacuation Stipulation, the Coordination Stipulation, the Blocks South of Baldwin County, Alabama, Stipulation, and the Protected Species Stipulation.

Endangered Species Act Section 7 Consultations, preformed with the National Oceanic and Atmospheric Administration Fisheries and Fish and Wildlife Service (NOAA Fisheries Service), may determine specific protective measures, such as the Marine Protected Species Stipulation included in previous lease sales. These measures will not be determined until consultations with NOAA Fisheries Service have been completed.

Application of lease stipulations will be considered by the Assistant Secretary of the Interior for Land and Minerals (ASLM). The analysis of the stipulations as part of the proposed actions does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from any proposed lease sale, nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions warrent. Any stipulations or mitigation requirements to be included in a lease sale will be described in the Final Notice of Sale for that lease sale. Mitigation measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease.

Scenarios Analyzed

Offshore activities are described in the context of scenarios for the proposed actions and for the OCS Program. The MMS's GOM OCS Region developed these scenarios to provide a framework for detailed analyses of potential impacts of the proposed lease sales. The scenarios are presented as ranges of the amounts of undiscovered, unleased hydrocarbon resources estimated to be leased and discovered as a result of a proposed action. The analyses are based on an assumed range of activities (for example, the installation of platforms, wells, and pipelines, and the number of helicopter operations and service-vessel trips) that would be needed to develop and produce the amount of resources estimated to be leased.

The cumulative analysis (**Chapter 4.5**) considers environmental and socioeconomic impacts that may result from the incremental impact of the lease sales when added to all past, present, and reasonably foreseeable future human activities, including non-OCS activities such as import tankering and commercial fishing, as well as all OCS activities (OCS Program). The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the 40-year analysis period (2007-2046). This includes projected activity from lease sales that have been held, including the most recent Lease Sale 200 (August 2006), but for which exploration or development has not yet begun or is continuing. In addition to human activities, impacts from natural occurrences, such as hurricanes, are analyzed.

Significant Issues

The major issues that frame the environmental analyses in this EIS are the result of concerns raised during years of scoping for Gulf of Mexico OCS Program. Issues related to OCS exploration, development, production, and transportation activities include oil spills, wetlands loss, air emissions, discharges, water quality degradation, trash and debris, structure and pipeline emplacement activities, platform removal, vessel and helicopter traffic, multiple-use conflicts, support services, population fluctuations, demands on public services, land-use planning, tourism, aesthetic interference, cultural impacts, environmental justice, and consistency with State coastal zone management programs. Environmental resources and activities determined through the scoping process to warrant an environmental analysis are water and air quality, sensitive coastal environments (coastal barrier beaches and associated dunes, wetlands, and seagrass communities), sensitive offshore resources, marine mammals, sea turtles, beach mice, endangered and threatened fish, coastal and marine birds, fisheries, recreational fishing, recreational resources, archaeological resources, and socioeconomic conditions.

Non-OCS issues included impacts from past and future hurricanes on environmental and socioeconomic resources, and on coastal and offshore infrastructure. During the past few years, the Gulf Coast States and GOM oil and gas activities have been impacted by several major hurricanes. **Appendix A.3** provides detailed information on Hurricanes Lili (2002), Ivan (2004), Katrina (2005), and Rita (2005), which are discussed in **Chapter 3 and Chapter 4**. The description of the affected environment (**Chapter 3**) includes impacts from these storms on the physical environment, biological environment, and socioeconomic activities and OCS-related infrastructure. Baseline data are considered in the assessment of impacts from the proposed actions to the resources and the environment (**Chapter 4)**.

Impact Conclusions

A summary of the potential impacts on each environmental and socioeconomic resource and the conclusions of the analyses can be found in **Chapters 2.3.1, 2.4.1, and 2.5.1**. The full analyses are presented in **Chapters 4.2.1** (impacts of routine activities from a proposed action in the WPA), **4.2.2** (impacts of routine activities from a proposed action in the CPA), and **4.4** (impacts from accidental events). An analysis of cumulative impacts is provided in **Chapter 4.5**. Below is a general summary of the potential impacts resulting from the proposed actions.

Air Quality: Emissions of pollutants into the atmosphere from routine activities associated with a proposed action are projected to have minimal impacts to onshore air quality, including emissions within the National Ambient Air Quality Standards (NAAQS), and increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} less than the maximum increases allowed in the Prevention of Significant Deterioration (PSD) Class II areas. However, accidents as a result of a proposed action may involve high concentrations of H_2S that could result in deaths as well as environmental damage. Other emissions of pollutants from accidental events as a result of a proposed action are not expected to have concentrations that would change onshore air quality classifications.

Coastal Waters: The impacts to coastal water quality from routine activities associated with a proposed action should be minimal as long as all existing regulatory requirements are met. However, as a result of accidental events associated with a proposed action, oil may also penetrate sand on the beach or be trapped in wetlands, where it can be re-released into the water some time after the initial spill.

Marine Waters: Regulations would limit the levels of contaminants in discharges of drilling fluids and cuttings from exploratory activities, and produced water and supply-vessel discharges during production activities. Therefore, the impacts to marine water quality from routine activities associated with a proposed action should be minimal as long as regulatory requirements are followed. Large spills as a result of accidental events associated with a proposed action could impact water quality. Chemical spills, the accidental release of synthetic-based fluids (SBF), and blowouts are expected to have temporary localized impacts on water quality.

Coastal Barrier Beaches and Associated Dunes: Effects to coastal barrier beaches and associated dunes from routine activities (pipeline emplacements, navigation channel use and dredging, and construction or continued use of infrastructure) associated with a proposed action are expected to be restricted to temporary and localized disturbances. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of accidental events associated with a proposed action. Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized.

Wetlands: Impacts to wetlands from routine activities associated with a proposed action are expected to be low and could be further reduced through mitigation. Loss of 0-8 ha (0-20 ac) of wetlands habitat is estimated as a result of 0-2 km (0-1.2 mi) of new pipelines projected as a result of a proposed action. Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts; a proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. Vessel traffic associated with a proposed action is expected to contribute minimally to the erosion and widening of navigation channels and canals. Secondary impacts to wetlands would be primarily from vessel traffic corridors and will continue to cause approximately 0.6 ha (1.5 ac) of landloss per year.

Offshore oil spills resulting from a proposed action are not expected to damage significantly any wetlands along the Gulf Coast. However, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in Galveston County and Matagorda County, Texas, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes, Louisiana, in the CPA. Impacts to wetland habitats from an oil spill associated with activities related to a proposed action would be expected to be low and temporary. Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment and personnel used to clean up a slick over the impacted area may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Seagrass Communities: Impacts to submerged vegetation by pipeline installation are projected to be very small and short term. Very little, if any, damage would then occur as a result of typical channel traffic associated with a proposed action. Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a proposed action and increased dredging is expected in an area that does not normally support seagrass beds. No permanent loss of seagrass is projected to result from oil contact unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Topographic Features: The proposed Topographic Features Stipulation could prevent most of the potential live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years. The proposed Topographic Features Stipulations will also assist in protecting most of the potential topographic feature communities from accidental events (blowouts and surface and subsurface oil spills). Recovery from incidences of impacts from blowouts would take place within 10 years. Contact with spilled oil would cause lethal and sublethal effects in benthic organisms, and the recovery of harmed benthic communities could take more than 10 years.

Chemosynthetic Deepwater Benthic Communities: Routine activities or accidental events associated with a proposed action are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience very minor (if any) impacts from drilling discharges or resuspended sediments located at more than 1,500 ft (457 m) away as required by NTL 2000-G20.

Nonchemosynthetic Deepwater Benthic Communities: Routine activities or accidental events associated with a proposed action are expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities. Impacts to other hard-bottom communities are expected to be avoided as a consequence of the application of the existing NTL 2000-G20 for chemosynthetic communities. The same geophysical conditions associated with the potential presence of chemosynthetic communities also results in hard carbonate substrate that is generally avoided.

Marine Mammals: Routine activities associated with a proposed action, particularly when mitigated as required by MMS, are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population endemic to the northern GOM. Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the GOM. Exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick is likely to result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to marine mammals.

Sea Turtles: While routine activities associated with a proposed action have the potential to harm sea turtles, they are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the GOM. Most routine OCS activities are expected to have sublethal effects. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. Accidental blowouts, oil spills, and spill-response activities associated with a proposed action have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to sea turtles. Sea turtle hatchling exposure to, fouling by, or consumption of tarballs persisting in the sea following the dispersal of an oil slick by would likely be fatal.

Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice: An impact from routine activities associated with a proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. Impact may result from consumption of beach trash and debris. Efforts undertaken for the removal of marine debris or for beach restoration, such as sand replenishment, may temporarily scare away beach mice, destroy their food resources, or collapse the tops of their burrows. Given the low probability of a major (≥1,000 bbl) spill occurring, direct impacts of oil spills on beach mice from a proposed action are highly unlikely. Oil-spill response and cleanup activities could have significant impact to the beach mice and their habitat, if not properly regulated.

Coastal and Marine Birds: The majority of effects resulting from routine activities associated with a proposed action on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. No significant habitat impacts are expected to occur directly from routine activities associated with a proposed action. Secondary impacts to coastal habitats will occur over the long term and may ultimately displace species from traditional sites to alternative sites. Oil spills from a proposed action pose the greatest potential for direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. The, air, vehicle, and foot traffic that takes place during shoreline cleanup activity can disturb nesting populations and degrade or destroy habitat.

Gulf Sturgeon: Routine activities resulting from a proposed action are expected to have negligible potential effects on Gulf sturgeon and their designated critical habitat. The Gulf sturgeon could be impacted by oil spills resulting from a proposed action. Contact with spilled oil could have detrimental physiological effects. However, several factors influence the probability of spilled oil contact with Gulf sturgeon or their critical habitat. The likelihood of spill occurrence and subsequent contact with, or impact to, Gulf sturgeon and/or designated critical habitat is extremely low.

Fish Resources and Essential Fish Habitat: Routine activities associated with a proposed action are expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in essential fish habitat (EFH). It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur. The effect of proposed-action-related oil spills on fish resources is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. At the expected level of impact, the resultant influence on fish populations from a proposed action would be negligible and indistinguishable from variations due to natural causes. It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Commercial Fishing: Routine activities associated with a proposed action, such as seismic surveys and pipeline trenching, will cause negligible impacts and will not deleteriously affect commercial fishing activities. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than 6 months for fishing activity to recover from any impacts. The effect of proposed-action-related oil spills on commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity would recover within 6 months. At the expected level of impact, the resultant influence on commercial fishing activities from a proposed action would be negligible and indistinguishable from variations due to natural causes. It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Recreational Fishing: The development of oil and gas in the proposed lease sale area could attract additional recreational fishing activity to structures installed on productive leases. Short-term, space-use conflict could occur during the time that any pipeline is being installed. Potential impacts on recreational fisheries due to accidental events as a result of a proposed action would be minor to moderate. Based on the sizes of oil spills assumed for a proposed action, only localized and short-term disruption of recreational fishing activity might result (minor impact).

Recreational Resources: A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users. The impact of marine debris on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short term and localized.

Historic Archaeological Resources: Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action are not expected to affect historic archaeological resources. Impacts to a historic archaeological resource could occur as a result of an accidental spill. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. Since historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

Prehistoric Archaeological Resources: A proposed action is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

Land Use and Coastal Infrastructure: There is sufficient land to construct new coastal infrastructure and to handle expansion of current facilities as a result of a proposed action. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure, requiring cleanup of any oil or chemicals spilled.

Demographics: Routine activities relating to a proposed action are expected to affect minimally the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one economic impact area (EIA). Baseline patterns and distributions of these factors are expected to maintain the same level. Changes in land use throughout the analysis area are expected to be contained and minimal. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

Economic Factors: There would be only minor economic changes in the Texas, Louisiana, Mississippi, Alabama, and Florida EIA's as the result of a proposed action. A proposed action is expected to generate less than a 1 percent increase in employment in any of the EIA's. The short-term social and economic consequences for the Gulf coastal region should a spill ≥1,000 bbl occur includes opportunity cost of employment and expenditures that could have gone to production or consumption rather than spill cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill.

Environmental Justice: The effects of a proposed action are expected to be widely distributed and little felt. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on minority or low-income people. Routine activities or accidental events associated with a proposed action are not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

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ABBREVIATIONS AND ACRONYMS

°C	degree Celsius
°F	degree Fahrenheit
2D	two-dimensional
3D	three-dimensional
4D	four-dimensional
^{210}Pb	Lead 210
ac	acre
ACAA	Alabama Coastal Area Act
ACAMP	Alabama Coastal Area Management Plan
ACP	Area Contingency Plans
ACT	American College Test
ADCNR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
AHTS	anchor-handling towing supply/mooring vessels
ANPR	Advance Notice of Proposed Rulemaking
ANWR	Aransas National Wildlife Refuge
APD	Application for Permit to Drill
API	American Petroleum Institute
API°	API degrees
AQRV	air quality related values
Area ID	Area Identification
ASLM	Assistant Secretary of the Interior for Land and Minerals
ASMFC	Atlantic States Marine Fisheries Commission
ATB	articulated tug barge
atm	atmosphere
b/d	barrels per day
BACT	best available control technology
BAST	best available and safest technology
bbl	barrel
BBO	billion barrels of oil
BBOE	billion barrel of oil equivalent
Bcf	billion cubic feet
Bcf/d	billion cubic feet per day
BiO	Biological Opinion
BNWA	Breton National Wildlife Refuge and National Wilderness Area
BOE	barrels of oil equivalent
BOPD	barrels of oil per day
BO	Biological Opinion
BOD	biochemical oxygen demand
BOP	blowout preventer
B.P.	before present
BPH	barrels per hour
BRD	bycatch reduction devices
BRD	Biological Resources Division (USGS)
CAA	Clean Air Act of 1970
CAAA	Clean Air Act Amendments of 1990
Call	Call for Information and Nominations
CBO	Congressional Budget Office
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resource System
CCA	Coastal Coordination Act (Texas)
CCMP	Comprehensive Conservation and Management Plan
CD	Consistency Determination
CDP	common-depth-point (seismic surveying)
CEE	controlled exposure experiment
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CEPRA	Coastal Erosion Planning and Response Act
CER	categorical exclusion review
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
cf.	compare, see
CFDL	Coastal Facilities Designation Line (Texas)
CFR	Code of Federal Regulations
CIAP	Coastal Impact Assistance Program
CID	Conservation Information Document
CIS	corrosion inhibiting substance
cm	centimeter
CMP	Coastal Management Plans
CNG	compressed natural gas
CNRA	Coastal Natural Resources Area
CO	carbon monoxide
COE	Corps of Engineers (U.S. Army)
COF	covered offshore facilities
CPA	Central Planning Area
CPS	coastal political subdivisions
CRS	Congressional Research Service
CSA	Continental Shelf Associates
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Protection, Planning & Restoration Act
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program

CZPA Coastal Zone Protection Act of 1996
DEIS draft environmental impact statement
DGD dual gradient drilling
DGoMB Deep Gulf of Mexico Benthos
DOCD development operations coordination document
DOD Department of Defense (U.S.)
DOE Office of Fossil Energy
DOI Department of the Interior (U.S.) (also: USDOI)
DOS Department of State
DOT Department of Transportation (U.S.) (also: USDOT)
DOTD Department of Transportation and Development
DP dynamically positioned
DWOP deepwater operations plan
DWPA Deepwater Ports Act of 1974
DWT dead weight tonnage
E&D exploration and development
E&P exploration and production
EA environmental assessment
EEZ Exclusive Economic Zone
EFH Essential Fish Habitat
e.g. for example
EIA Economic Impact Area
EIA Energy Information Administration (USDOE)
EIS environmental impact statement
EP exploration plan
EPA Eastern Planning Area
ERS Economic Research Service
ESA Endangered Species Act of 1973
ESI Environmental Sensitivity Indices
ESP Environmental Studies Program
ESPIS Environmental Studies Program Information System
et al. and others
et seq. and the following
EWTA Eglin Water Test Area
FAA Federal Aviation Administration
FAD fish attracting device
FCF Fishermen's Contingency Fund
FDA Food and Drug Administration
FDEP Florida Department of Environmental Protection
FEIS final environmental impact statement
FEMA Federal Emergency Management Agency
FERC Federal Energy Regulatory Commission
FGB Flower Garden Banks
FGBNMS Flower Garden Banks National Marine Sanctuary
FLM Federal Land Manager
FMC Fishery Management Council
FMP Fishery Management Plan
FNOS Final Notice of Sale
FO Field Operations
FONSI Finding of No Significant Impact
FONNSI Finding of No New Significant Impact
FPS floating production system
FPSO floating production, storage, and offloading system
FR *Federal Register*
ft feet
FWS Fish and Wildlife Service
FY fiscal year
G&G geological and geophysical
gal gallon
GBS gravity-based structure
GEMS Gulf Ecological Management Site
GERG Geochemical and Environmental Research Group
GINS Gulf Islands National Seashore
GIS geographical information system
GIWW Gulf Intracoastal Waterway
GLO General Land Office
GLPC Greater Lafourche Port Commission
GMAQS Gulf of Mexico Air Quality Study
GMFMC Gulf of Mexico Fishery Management Council
GMP Gulf of Mexico Program
GOM Gulf of Mexico
GP General Permit
GPS global positioning system
GS Geological Survey (also: USGS)
GSA Geological Survey of Alabama
GSMFC Gulf States Marine Fisheries Commission
GT gross tons
GTFP green turtle fibropapillomatosis
H_2S hydrogen sulfide
ha hectare
ha/km hectare per kilometer
HAPC Habitat Areas of Particular Concern
HCl hydrochloric
HI High Island
HIPPS high-integrity pressure protection system
HMS highly migratory species
HPHT high-pressure, high-temperature
hr hour
Hz hertz
IADC International Association of Drilling Contractors
ICC International Beach Cleanup

ICCAT	International Commission for the Conservation of Atlantic Tunas
i.e.	specifically
in	inch
INTERMAR	International Activities and Marine Minerals Division (MMS)
IPF	impact-producing factor
IT	incidental take
ITS	Incidental Take Statement
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
kg	kilogram
kHz	kilohertz
kJ	kilojoule
km	kilometer
kn	knot
LA	Louisiana
LADEQ	Louisiana Department of Environmental Quality
LADNR	Louisiana Department of Natural Resources (also: LDNR)
LA Hwy 1	Louisiana Highway 1
LARI	Louisiana Artificial Reef Initiative
LATEX	Texas-Louisiana Shelf Circulation and Transport Process Program (MMS-funded study)
lb	pound
LCE	Loop Current Eddy
LCRP	Louisiana Coastal Resources Program
LDNR	Louisiana Department of Natural Resources (also: LADNR)
LMA	
LNG	liquefied natural gas
LOOP	Louisiana Offshore Oil Port
LPG	liquefied petroleum gas
LSU	Louisiana State University
LTL	Letters to Lessees
LWC	loss of well control
LWCF	Land and Water Conservation Fund
m	meter
m/yr	meters per year
MAFLA	Mississippi, Alabama, and Florida
MARAD	U.S. Department of Transportation Maritime Administration
MARPOL	International Convention for the Prevention of Pollution from Ships
Mbbl	thousand barrels
Mcf	thousand cubic feet
MCP	Mississippi Coastal Program
MDP	Marine Debris Monitoring Program
MFCMA	Magnuson Fishery Conservation and Management Act of 1976
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act of 1976
MFO	mixed-function oxygenase
mg	milligram
mg/l	milligrams per liter
mi	mile
mm	millimeter
MMB	Marine Minerals Branch
MMbbl	million barrels
MMbbl/day	million barrels per day
MMBOE	million barrels of oil equivalent
MMBtu	million British thermal units
MMC	Marine Mammal Commission
MMcf/d	million cubic feet per day
MMCFPD	million cubic feet per day
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MOA	Memorandum of Agreement
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MPD	managed pressure drilling
MPPRCA	Marine Plastic Pollution Research and Control Act of 1987
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
MPSV	multi-purpose supply vessels
MRFSS	Marine Recreational Fisheries Statistics Survey
MRGO	Mississippi River Gulf Outlet
MSA	Metropolitan Statistical Area
MSD	marine sanitation device
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSRC	Marine Spill Response Corporation
MSW	municipal solid waste
Mta	million metric tons annually
MTBE	methyl tertiary butyl ether
MW	megawatts
Mya	Million years ago
N.	north
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NACOSH	National Advisory Committee on Occupational Safety and Health
ng	nanogram (one-billionth of a gram)
NARP	National Artificial Reef Plan
NAS	National Academy of Sciences
NEGOM	northeastern GOM
NEP	National Estuary Program

NEPA National Environmental Policy Act
NERBC New England River Basins Commission
NFEA National Fishing Enhancement Act
NGL natural-gas liquids
NGVD National Geodetic Vertical Depth
NHPA National Historic Preservation Act
NHS National Highway System
NIOSH National Institute for Occupational Safety and Health
NMFS National Marine Fisheries Service
nmi nautical-mile
NMS National Marine Sanctuary
NOA Notice of Availability
NOAA National Oceanic and Atmospheric Administration
NOD New Orleans District
NOI Notice of Intent to Prepare an EIS
NORM naturally occurring radioactive material
NOS National Ocean Service
NOSAC National Offshore Safety Advisory Committee
NO_x nitrogen oxides
NOW nonhazardous oil-field waste
NPDES National Pollutant and Discharge Elimination System
NPFC National Pollution Funds Center
NPS National Park Service
NRC National Research Council
NRDA Natural Resource Damage Assessment
NSRE National Survey on Recreation and the Environment
NTL Notice to Lessees and Operators
NTU nephelometric units
NUT new or unusual technology
NWRC National Wetland Research Center
OBC ocean bottom cables
OBF oil-based drilling fluids
OCD Offshore and Coastal Dispersion Model
OCRM Office of Ocean and Coastal Resource Management
OCS Outer Continental Shelf
OCSLA Outer Continental Shelf Lands Act
ODD Ocean Disposal Database
OPA Oil Pollution Act of 1990
OPA 90 Oil Pollution Act of 1990
OPEC Organization for Petroleum Exporting Countries
ORV open rack vaporizer
OSCP Oil Spill Contingency Plan
OSFR oil-spill financial responsibility
OSHA Occupational Safety and Health Administration
OSLTF Oil Spill Liability Trust Fund
OSM Office of Safety Management
OSRA Oil Spill Risk Analysis
OSRO Oil Spill Removal Organization
OSRP oil-spill response plans
OSV offshore supply/service vessels
P.L. Public Law
PAH polynuclear aromatic hydrocarbon
PCB polychlorinated biphenyl
PDQ production, drilling, and quarters
PEA programmatic environmental assessment
PINC Potential Incident of Noncompliance
PINS Padre Island National Seashore
PM_{10} particulate matter smaller than 10 microns in size
PNOS Proposed Notice of Sale
ppb part per billion
ppm parts per million
ppt parts per thousand
PSD Prevention of Significant Deterioration
PSI pounds per square inch
PSV platform supply vessel
R&D research and development
RCRA Resource Conservation and Recovery Act
RD Regional Director
RFG reformulated motor gasoline
ROTAC Regional Operations Technology Assessment Committee
ROV remotely operated vehicle
RP Recommended Practice
RRC Railroad Commission
RS Regional Supervisor
RS-FO Regional Supervisor for Field Operations
RTR Rigs-to-Reef
S. south
SAFMC South Atlantic Fishery Management Councils
SARA Superfund Amendments and Reauthorization Act
SAT School-based Administration Test
SBF synthetic-based drilling fluid
SCRS Standing Committee for Research and Science
SEAMAP Southeastern Area Monitoring and Assessment Program
SEIS supplemental environmental impact statement
SERO Southeast Regional Office
SIC Standard Industrial Classification

SIP	State implementation plan
SITP	shut-in tubing pressure
SOLAS	Safety of Life at Sea
SO_2	sulphur dioxide
SO_x	sulphur oxides
sp.	species
spp.	multiple species
SPR	spawning potential ratio
Stat.	Statutes
SWSS	Sperm Whale Seismic Study
TA&R	Technical Assessment & Research Program (MMS)
TAAS	Texas Assessment of Academic Skills
TAC	total allowable catch
TAMU	Texas A&M University
Tcf	trillion cubic feet
TCMP	Texas Coastal Management Plan
TD	total depth
TED	turtle excluder device
TEWG	Turtle Expert Working Group
TGLO	Texas General Land Office
THC	total hydrocarbon content
TIMS	Technical Information Management System (MMS)
TKN	total Kjeldahl nitrogen
TL	total length
TLP	tension leg platform
TOC	total organic carbon
tonnes	a long ton or metric ton—2,200 lb
TRW	topographic Rossby wave
TSP	total suspended particulate matter
TSS	traffic separation schemes
TVD	true vertical depth
TWC	treatment, workover, and completion
TX	Texas
U.S.	United States
USACE	U.S. Dept. of the Army, Corps of Engineers
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior (also: DOI)
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey (also: GS)
VOC	volatile organic compounds
VSP	vertical seismic profiling
W.	west
WBF	water-based drilling fluids
WBNP	Wood Buffalo National Park
WPA	Western Planning Area
yd	yard

CONVERSION CHART

To convert from	To	Multiply by
millimeter (mm)	inch (in)	0.03937
centimeter (cm)	inch (in)	0.3937
meter (m)	foot (ft)	3.281
kilometer (km)	mile (mi)	0.6214
meter^2 (m^2)	foot^2 (ft^2)	10.76
	yard^2 (yd^2)	1.196
	acre (ac)	0.0002471
hectare (ha)	acre (ac)	2.47
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
meter^3 (m^3)	foot^3 (ft^3)	35.31
yard^3 (yd^3)	1.308	
liter (l)	gallons (gal)	0.2642
degree Celsius (°C)	degree Fahrenheit (°F)	°F = (1.8 x °C) + 32

1 barrel (bbl) = 42 gal = 158.9 l = approximately 0.1428 metric tons
tonnes = 1 long ton or 2,200 lb
1 nautical mile (nmi) = 6,076 ft or 1.15 mi

CHAPTER 1

THE PROPOSED ACTIONS

1. THE PROPOSED ACTIONS

1.1. PURPOSE OF AND NEED FOR THE PROPOSED ACTIONS

The proposed Federal actions addressed in this environmental impact statement (EIS) are 11 areawide oil and gas lease sales in the Western Planning Area (WPA) and Central Planning Area (CPA) of the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) (**Figure 1-1**). Under the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (5-Year Program), two sales would be held each year—one in the WPA and one in the CPA (**Table 1-1**). The proposed WPA lease sales are Sale 204 in 2007, Sale 207 in 2008, Sale 210 in 2009, Sale 215 in 2010, and Sale 218 in 2011; the proposed CPA lease sales are Sale 205 in 2007, Sale 206 in 2008, Sale 208 in 2009, Sale 213 in 2010, Sale 216 in 2011, and Sale 222 in 2012. The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources. The proposed lease sales will provide qualified bidders the opportunity to bid upon and lease acreage in the GOM OCS in order to explore, develop, and produce oil and natural gas. This EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. Although this EIS addresses eleven proposed lease sales, at the completion of this EIS process, decisions will be made only for proposed Lease Sale 204 in the WPA and proposed Lease Sale 205 in the CPA. A National Environmental Policy Act (NEPA) review will be conducted for each subsequent proposed lease sale in the 5-Year Program. Informal and formal consultations with other Federal agencies, the affected States, and the public will be carried out to assist in the determination of whether or not the information and analyses in this original multisale EIS are still valid. These consultations and NEPA reviews will be completed before decisions are made on the subsequent sales.

The Outer Continental Shelf Lands Act (OCSLA) of 1953 (67 Stat. 462), as amended (43 U.S.C. 1331 *et seq*. (1988)), established Federal jurisdiction over submerged lands on the OCS seaward of the State boundaries. Under the OCSLA, the Department of the Interior (DOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary of the Interior (Secretary) oversees the OCS oil and gas program and is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained. The Act empowers the Secretary to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the Act. The Secretary has designated the Minerals Management Service (MMS) as the administrative agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after lease issuance.

The Western and Central GOM constitutes one of the world's major oil and gas producing areas, and has proved a steady and reliable source of crude oil and natural gas for more than 50 years. Oil from the GOM can help reduce the Nation's need for oil imports and reduce the environmental risks associated with oil tankering. Natural gas is generally considered to be an environmentally preferable alternative to oil, both in terms of the production and consumption.

1.2. DESCRIPTION OF THE PROPOSED ACTIONS

The proposed actions are 11 oil and gas lease sales in the WPA and CPA as scheduled under the proposed 5-Year Program for 2007-2012. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since the proposed lease sales in each lease sale area and their projected activities are very similar, MMS has decided to prepare a single EIS for the 11 WPA and CPA lease sales in the proposed 5-Year Program.

Proposed WPA Lease Sales 204, 207, 210, 215, and 218

The proposed WPA lease sales are Sale 204 in 2007, Sale 207 in 2008, Sale 210 in 2009, Sale 215 in 2010, and Sale 218 in 2011. The WPA encompasses about 28.6 million acres (ac) located 3 leagues (10 miles (mi)) offshore Texas and extends seaward to the limits of the EEZ in water depths up to 3,346 meters (m) (10,978 ft) (**Figure 1-1**). Each WPA proposed lease sale would offer for lease all unleased blocks in the WPA for oil and gas operations (**Figure 1-1**), with the following exceptions:

(1) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary; and

(2) whole and partial blocks that lie within the 1.4-nautical-mile (nmi) buffer zone north of the continental shelf boundary between the United States (U.S.) and Mexico, for Sales 204, 207, 210, and 215 only.

The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.242-0.423 billion barrels of oil (BBO) and 1.644-2.647 trillion cubic feet (Tcf) of gas. The proposed WPA lease sales include proposed lease stipulations designed to reduce environmental risks and are discussed in **Chapter 2.3**.

Proposed CPA Lease Sales 205, 206, 208, 210, 213, 216, and 222

The proposed CPA lease sales are Sale 205 in 2007, Sale 206 in 2008, Sale 208 in 2009, Sale 213 in 2010, Sale 216 in 2011, and Sale 222 in 2012. The CPA sale area encompasses about 58.7 million ac of the CPA's 66.3 million ac and is located 3 nmi offshore Louisiana, Mississippi, and Alabama and extends seaward to the limits of the EEZ in water depths up to 3,458 m (11,345 ft) (**Figure 1-1**). Each subsequent proposed CPA sale would offer for lease all unleased blocks in the CPA for oil and gas operations (**Figure 1-1**), with the following exceptions:

(1) blocks directly south of Florida and within 100 mi of the Florida coast (north of the easternmost portion of the CPA sale area as shown on **Figure 1-1**);

(2) blocks under an existing Presidential withdrawal through 2012, as well as subject to annual congressional moratoria (southeastern portion of the CPA sale area as shown on **Figure 1-1**);

(3) blocks that are beyond the U.S. Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(4) whole and partial blocks that lie within the 1.4-nmi buffer zone north of the continental shelf boundary between the U.S. and Mexico, for Sales 205, 206, 208, and 213 only.

The estimated amount of resources projected to be developed as a result of any one proposed CPA lease sale is 0.776-1.292 BBO and 3.236-5.229 Tcf of gas. The subsequent, proposed CPA lease sales include proposed lease stipulations designed to reduce environmental risks and are discussed in **Chapter 2.4**.

1.3. Regulatory Framework

Federal laws mandate the OCS leasing program (i.e., Outer Continental Shelf Lands Act) and the environmental review process (i.e., National Environmental Policy Act). Several Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies (i.e., Coastal Zone Management Act, Endangered Species Act, the Magnuson Fishery Conservation and Management Act, and the Marine Mammal Protection Act). In addition, the OCS leasing process and all activities and operations on the OCS must comply with other Federal, State, and local laws and regulations. The following are summaries of the major, applicable, Federal laws and regulations.

Outer Continental Shelf Lands Act

The OCSLA of 1953 (43 U.S.C. 1331 *et seq.*), as amended, established Federal jurisdiction over submerged lands on the OCS seaward of State boundaries. The Act, as amended, provides guidelines for implementing an OCS oil and gas exploration and development program. The basic goals of the Act include the following:

- to establish policies and procedures for managing the oil and natural gas resources of the OCS that are intended to result in expedited exploration and development of the OCS in order to achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade;
- to preserve, protect, and develop oil and natural gas resources of the OCS in a manner that is consistent with the need
  - to make such resources available to meet the Nation's energy needs as rapidly as possible;
  - to balance orderly resource development with protection of the human, marine, and coastal environments;
  - to ensure the public a fair and equitable return on the resources of the OCS; and
  - to preserve and maintain free enterprise competition; and
- to encourage development of new and improved technology for energy resource production, which will eliminate or minimize the risk of damage to the human, marine, and coastal environments.

Under the OCSLA, the Secretary of the Interior is responsible for the administration of mineral exploration and development of the OCS. Within the DOI, the MMS is charged with the responsibility of managing and regulating the development of OCS oil and gas resources in accordance with the provisions of the OCSLA. The MMS operating regulations are in Chapter 30, Code of Federal Regulations, Part 250 (30 CFR 250); 30 CFR 251; and 30 CFR 254.

Enacted August 8, 2005, the Energy Policy Act amended Section 8 of the OCSLA to authorize DOI to grant leases, easements, or rights-of-way on the OCS for the development and support of energy resources from sources other than oil and gas and to allow for alternate uses of existing facilities on the OCS.

Under Section 20 of the OCSLA, the Secretary shall ". . . conduct such additional studies to establish environmental information as he deems necessary and shall monitor the human, marine, and coastal environments of such area or region in a manner designed to provide time-series and data trend information which can be used for comparison with any previously collected data for the purpose of identifying any significant changes in the quality and productivity of such environments, for establishing trends in the area studied and monitored, and for designing experiments to identify the causes of such changes." Through the Environmental Studies Program (ESP), the MMS conducts studies designed to provide information on the current status of resources of concern and notable changes, if any, resulting from OCS Program activities.

In addition, the OCSLA provides a statutory foundation for coordination with the affected States and, to a more limited extent, local governments. At each step of the procedures that lead to lease issuance, participation from the affected States and other interested parties is encouraged and sought.

National Environmental Policy Act

The NEPA of 1969 (42 U.S.C. 4321 *et seq.*) provides a national policy that encourages "productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man . . . ." The NEPA requires that all Federal agencies use a systematic, interdisciplinary approach to protection of the human environment; this approach will ensure the integrated use of the natural and social sciences in any planning and decisionmaking that may have an impact upon the environment. The NEPA also requires the preparation of a detailed EIS on any major Federal action that may have a significant impact on the environment. This EIS must address any adverse environmental effects that cannot be avoided or mitigated, alternatives to the proposed action, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources involved in the project.

In 1979, the Council on Environmental Quality (CEQ) established uniform guidelines for implementing the procedural provisions of NEPA. These regulations (40 CFR 1500 to 1508) provide for the use of the NEPA process to identify and assess the reasonable alternatives to proposed actions that avoid or minimize adverse effects of these actions upon the quality of the human environment. "Scoping" is used to identify the scope and significance of important environmental issues associated with a proposed Federal action through coordination with Federal, State, and local agencies; the public; and any interested individual or organization prior to the development of an impact statement. The process is also intended to identify and eliminate, from further detailed study, issues that are not significant or that have been covered by prior environmental review.

The following Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (16 U.S.C. 1451 *et seq*.) was enacted by Congress in 1972 to develop a national coastal management program that comprehensively manages and balances competing uses of and impacts to any coastal use or resource. The national coastal management program is implemented by individual State coastal management programs in partnership with the Federal Government. The CZMA Federal consistency regulations require that Federal activities (e.g., OCS lease sales) be consistent to the maximum extent practicable with the enforceable policies of a State's coastal management program. The Federal consistency regulations also require that other federally approved activities (e.g., activities requiring Federal permits, such as activities described in OCS plans) be consistent with a State's federally approved coastal management program. The Federal consistency requirement is an important mechanism to address coastal effects, to ensure adequate Federal consideration of State coastal management programs, and to avoid conflicts between States and Federal agencies. The Coastal Zone Act Reauthorization Amendments of 1990 (CZARA), enacted November 5, 1990, as well as the Coastal Zone Protection Act of 1996 (CZPA), amended and reauthorized the CZMA. The CZMA is administered by the Office of Ocean and Coastal Resource Management (OCRM) within NOAA's NOS. The NOAA's implementing regulations are found at 15 CFR 930, with the latest revision being published in the *Federal Register* on January 5, 2006.

The Endangered Species Act

The Endangered Species Act (ESA) (16 U.S.C. 1631 *et seq*.) of 1973, as amended (43 U.S.C. 1331 *et seq*.), establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. The ESA is administered by FWS and NOAA's National Marine Fisheries Service (NOAA Fisheries Service). Section 7 of the ESA governs interagency cooperation and consultation. Under Section 7, MMS consults with both NOAA Fisheries Service and FWS to ensure that activities on the OCS under MMS jurisdiction do not jeopardize the continued existence of threatened or endangered species and/or result in adverse modification or destruction of their critical habitat.

Through a biological assessment or an informal consultation, NOAA Fisheries Service and FWS determine the affect of a proposed action on a listed species or critical habitat. If either agency determines a proposed action would be likely to adversely affect either a listed species or critical habitat, a formal consultation is initiated. The formal consultation process commences with MMS's written request for consultation and concludes with NOAA Fisheries Service and FWS each issuing a Biological Opinion (BiO).

In their BiO's, NOAA Fisheries Service and FWS make recommendations on the modification of oil and gas operations to minimize adverse impacts, although it remains the responsibility of MMS to ensure that proposed OCS activities do not impact threatened and endangered species. If an unauthorized taking occurs or if the authorized level of incidental take (as described in the previous section) is exceeded, reinitiation of formal consultation is likely required.

In 1988, MMS requested a "generic" consultation from NOAA Fisheries Service pursuant to Section 7 of the ESA concerning potential impacts on endangered and threatened species associated with explosive-severance activities conducted during structure-removal operations. Much like the PEA, the consultation's "generic" BiO was limited to the best scientific information available and concentrated primarily on the majority of structure removals (water depths <200 m). The Incidental Take Statement (ITS) was therefore limited to the five species of sea turtle found on the shallow shelf. Reporting guidelines and specific mitigation measures are outlined in the ITS and include (1) the use of a qualified NOAA Fisheries Service observer, (2) aerial surveys, (3) detonation delay radii, (4) nighttime blast restrictions, (5) charge staggering and grouping, and (6) possible diver survey requirements.

Emphasizing a continued need for an incentive to keep explosive weights low, MMS formally requested that NOAA Fisheries Service amend the 1988 BiO to establish a minimum charge size of 5 lb. The NOAA Fisheries Service Southeast Regional Office subsequently addressed explosive charges ≤5 lb in a separate, informal BiO. The October 2003 "de-minimus" BiO waives several mitigative measures of the "generic" 1988 BiO (i.e., aerial observations, 48-hr pre-detonation observer coverage, on-site NOAA personnel, etc.), reduces the potential impact zone from 3,000 ft to 700 ft, and gives the operators/severing contractors the opportunity to conduct their own observation work.

On February 28, 2005, MMS submitted the new structure-removal PEA and a petition for new Incidental-Take Regulations under the MMPA to NOAA Fisheries Service. Since agency rulemaking is considered a major Federal activity, NOAA Fisheries Service is also conducting a Section 7 Consultation on its own MMPA regulatory efforts. The agency expects to issue a new BiO and ITS to supersede the current "generic" and "de-minimus" BiO's by the end of 2006.

The Magnuson Fishery Conservation and Management Act

The Magnuson Fishery Conservation and Management Act (MFCMA) of 1976 (16 U.S.C. 1251 *et seq*.) established and delineated an area from the States' seaward boundary outward 200 nautical miles (nmi) as a fisheries conservation zone for the U.S. and its possessions. The Act established national standards for fishery conservation and management. It is now named the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

Congress amended and reauthorized the MSFCMA through passage of the Sustainable Fisheries Act of 1996. The Act, as amended, established eight Regional Fishery Management Councils (FMC's) to exercise sound judgment in the stewardship of fishery resources through the preparation, monitoring, and revision of fishery management plans (FMP). An FMP is based upon the best available scientific and economic data. The reauthorization also promotes domestic commercial and recreational fishing under sound conservation and management principles, including the promotion and catch and release programs in recreational fishing and encouraging the development of currently underutilized fisheries. The reauthorization requires that the FMC's identify Essential Fish Habitat (EFH). To promote the protection of EFH, Federal agencies are required to consult on activities that may adversely affect EFH designated in the FMP's. The MSFCMA is in the process of being reauthorized at the time of this writing through a draft bill, S. 2012, sponsored by Senators Ted Stevens and Dan Inouye. When passed, this bill will authorize appropriations for the years 2006-2012.

Essential Fish Habitat

There are FMP's in the GOM OCS region for shrimp, red drum, reef fishes, coastal migratory pelagics, stone crabs, spiny lobsters, coral and coral reefs, billfish, and highly migratory species (HMS). The Gulf of Mexico Fishery Management Council's (GMFMC) *Generic Amendment for Addressing Essential Fish Habitat Requirements* (1998) amends the first seven FMP's listed above, identifying estuarine/inshore and marine/offshore EFH for over 450 managed species (about 400 in the Coral FMP). Although not part of the GMFMC's FMP's, separate FMP's have been finalized by NOAA Fisheries Service for Atlantic tunas, swordfish and sharks, and the Atlantic billfish fishery (USDOC, NMFS, 1999a and b).

The GMFMC's *Generic Amendment for Addressing Essential Fish Habitat Requirements* identifies threats to EFH and makes a number of general and specific habitat preservation recommendations for pipelines and oil and gas exploration and production activities within State waters and OCS areas (**Chapter 3.2.8.2**, Essential Fish Habitat). In 2005, a new amendment to the original EFH Generic Amendment was finalized (GMFMC, 2005b). The purpose of this action was to amend each of the seven GOM Fishery Management Plans (FMP's) to (1) describe and identify EFH for the fisheries, (2) minimize to the extent practicable the adverse effects of fishing on such EFH; and (3) encourage the conservation and enhancement of such EFH. This is pursuant to the mandate contained in Section 303(a)(7) of the MSFCMA. To support the description and identification of EFH and to address adverse fishing impacts for all managed GOM species, the GMFMC undertook, over a two-year period, a detailed analysis of the GOM's physical environment; oceanographic features; estuarine, nearshore, and offshore habitats; all fishery resources; and marine mammals and protected species. The analysis resulted in a Final EFH Environmental Impact Statement (EIS) (GMFMC, 2004) for the seven FMP's. As a result of analyses from the Final EIS, the GMFMC proposed actions to describe and identify EFH, to establish habitat areas of particular concern (HAPC), and to address adverse effects of fishing on EFH. The NOAA Fisheries Service approved these revisions, and the rule implementing the changes became effective January 23, 2006. One of the most significant proposed changes in this amendment will reduce the extent of EFH relative to the 1998 Generic Amendment by removing EFH description and identification from waters between 100 fathoms and the seaward limit of the EEZ.

The MMS and NOAA Fisheries Service have previously entered into a programmatic–level consultation agreement for EFH related to OCS activities in all of the lease areas described in this EIS. The EFH conservation measures recommended by NOAA Fisheries Service serve the purpose of protecting EFH and include avoidance distances from topographic-feature's No Activity Zones and live-bottom pinnacle features. Additional conservation provisions and circumstances that require project-specific consultation have also been agreed to through this Programmatic Consultation. These agreements, including avoidance distances from topographic-feature's No Activity Zones and live-bottom pinnacle features appear in Notice to Lessees and Operators (NTL) 2004-G05. A new request for Programmatic Consultation was initiated with the completion of the Draft EIS.

Essential Fish Habitat Consultation

This EIS includes the required components of an EFH assessment that represents a submission to NOAA Fisheries Service in request of an EFH consultation. Each of these required components are outlined below, together with the associated sections of this EIS where EFH discussion and other related material can be located.

I. A description of a proposed action:

Chapters 1.2, 2.3.1.1, and 2.4.1.1. Description of the environment appears throughout **Chapter 3** with specific sections on fishery resources and EFH in **Chapter 3.2.8.2.**

II. An analysis of the effects, including cumulative effects, of a proposed action on EFH:

Routine operations in **Chapters 4.2.1.1.8 and 4.2.2.1.10**; accidental events in **Chapter 4.4.10**; and cumulative impacts in **Chapter 4.5.10.**

III. The MMS's views regarding the effects of an action on EFH:

Summary and conclusion statements are included with each impact discussion outlined under item II above. Summaries of impacts also appear in **Chapter 2.**

IV. Proposed mitigations:

Mitigations are presented in **Chapter 2.2.2.** Additional mitigating measures include lease stipulations, discussed in **Chapters 2.3.1.3, and 2.4.1.3.** The programmatic consultation agreement between MMS and NOAA Fisheries Service includes "Additional EFH Conservation Recommendations" outlined in **Chapter 3.2.8.2.**

The Marine Mammal Protection Act

Under the Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. 1361 *et seq.*), the Secretary of Commerce is responsible for all cetaceans and pinnipeds, except walruses. Authority for implementing the Act is delegated to the NOAA Fisheries Service. The Secretary of the Interior is responsible for walruses, polar bears, sea otters, manatees, and dugongs. Authority is delegated to the Fish and Wildlife Service (FWS). The Act established the Marine Mammal Commission (MMC) and its Committee of Scientific Advisors on Marine Mammals to provide oversight and advice to the responsible regulatory agencies on all Federal actions bearing upon the conservation and protection of marine mammals.

The MMPA established a moratorium on the taking of marine mammals in waters under U.S. jurisdiction. The MMPA defines "take" to mean "to harass, harm, shoot, wound, trap, hunt, capture, or kill, or attempt to engage in any such conduct (including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts)." Harassment is the most common form of taking associated with OCS Program activities. The moratorium may be waived when the affected species or population stock is within its optimum sustainable population range and will not be disadvantaged by an authorized taking (e.g., will not be reduced below its maximum net productivity level, which is the lower limit of the optimum sustainable population range). The Act directs that the Secretary, upon request, authorize the unintentional taking of small numbers of marine mammals incidental to activities other than commercial fishing (e.g., offshore oil and gas exploration and development) when, after notice and opportunity for public comment, the Secretary finds that the total of such taking during the 5-year (or less) period will have a negligible impact on the affected species. The MMPA also specifies that the Secretary shall withdraw, or suspend, permission to unintentionally take marine mammals incidental to activities such as oil and gas development if, after notice and opportunity for public comment, the Secretary finds (1) that the applicable regulations regarding methods of taking, monitoring, or reporting are not being complied with or (2) the taking is, or may be, having more than a negligible impact on the affected species or stock.

In 1994, a subparagraph (D) was added to the MMPA to simplify the process for obtaining "small take" exemptions when unintentional taking incidental to activities such as offshore oil and gas development is by harassment only. Specifically, incidental take (IT) by harassment can now be authorized by permit for periods of up to one year (as opposed to the lengthy regulation/Letter of Authorization process that was formerly in effect). The new language also sets a 120-day time limit for processing harassment IT authorizations. In 1989, the American Petroleum Institute (API) petitioned NOAA Fisheries Service under Subpart A of the Marine Mammal Protection Act (MMPA) regulations for the incidental take of spotted and bottlenose dolphins during structure-removal operations (i.e., for either explosive- or nonexplosive-severance activities). The Incidental Take Authorization regulations were promulgated by NOAA Fisheries Service in October 1995 (60 FR 53139, October 12, 1995), and on April 10, 1996 (61 FR 15884), the regulations were moved to Subpart M (50 CFR 216.141 et seq.). Effective for 5 years, the regulations detailed conditions, reporting requirements, and mitigative measures similar to those listed in the 1988 Endangered Species Act (ESA) Consultation requirements for sea turtles. After the regulations expired in November 2000, NOAA Fisheries Service and MMS advised operators to continue following the guidelines and mitigative measures of the lapsed subpart pending a new petition and subsequent regulations. At industry's prompting, NOAA Fisheries Service released Interim regulations in August 2002, which expired on February 2, 2004. Operators have continued to follow the Interim conditions until NOAA Fisheries Service promulgates new regulations.

The MMS recently prepared a new programmatic environmental assessment (PEA), *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf* (USDOI, MMS, 2005a), to evaluate the full range of potential environmental impacts of structure-removal activities in all water depths in the CPA and WPA and the Sale 181/189 area in the EPA of the Gulf of Mexico. On February 28, 2005, MMS submitted the new structure-removal PEA and a petition for new Incidental-Take Regulations under the MMPA to NOAA Fisheries Service. After review of the petition and PEA, NOAA Fisheries Service published a notice of receipt of MMS's petition in the *Federal Register* on August 24, 2005. Only one comment was received by NOAA Fisheries Service during the public comment period. On April 7, 2006, NOAA Fisheries Service published the proposed rule for the incidental take of marine mammals under the MMPA in the *Federal Register*. The subsequent public comment period ended May 22, 2006, and MMS expects the Final Rule to be published in the *Federal Register* in mid-to-late summer 2006.

The Clean Air Act

The 1970 Clean Air Act (CAA) (42 U.S.C. 7401 *et seq*.) established the National Ambient Air Quality Standards (NAAQS), and required the promulgation of national primary and secondary standards. The primary NAAQS standards were established to protect public health and the secondary standards to protect public welfare. Under the CCA, the U.S. Environmental Protection Agency (USEPA) sets limits on how much of a pollutant can be in the air anywhere in the U.S. Although the CAA is a Federal law covering the entire nation, the states do much of the work to implement the Act. The law allows individual states to have more stringent pollution controls, but states are not allowed to have less stringent pollution controls than those for the rest of the U.S. The law recognizes that states should take the lead in carrying out the CAA because pollution control problems often require in-depth understanding of local; meteorology, industries, geography, housing patterns, etc.

States may be required to develop state implementation plans (SIP's) that explain how they will comply with, or remain in compliance with the CAA. The states must involve the public, through hearings and opportunities to comment, in the development of the SIP. The USEPA must approve the SIP, and if the SIP is not acceptable, USEPA can take over enforcing the CAA in that state. The U.S. Government, through USEPA, assists the states with air quality compliance by providing scientific research, expert studies, engineering designs, and money to support clean air programs.

The CAA established the Prevention of Significant Deterioration (PSD) program to preserve, protect, and enhance the air quality in special regions of the U.S. Under the PSD program, these special air quality regions were designated as Class I areas. Class I areas, are areas of special national or regional natural, scenic, recreational, or historic value for which the PSD regulations provide special protection. The Federal Land Manager (FLM) for a Class I area is responsible for defining specific Air Quality Related Values (AQRV) for the area and for establishing the criteria to determine any adverse impact on the area's AQRV. If a FLM determines that a source will adversely impact AQRV in a Class I area, the FLM may recommend that the permitting agency deny issuance of the permit, however, the permitting authority has the final decision to issue or deny the permit. In the GOM OCS Region, the Fish and Wildlife Service is the FLM for the Breton, St. Marks, Okefenokee, and Chassahowitzka Class I areas and the National Park Service is the FLM for the Everglades Class I area.

The CAA also delineates GOM air quality jurisdictional boundaries between the USEPA and DOI. Operations on the GOM OCS, east of 87.5° W. longitude are subject to USEPA air quality regulations and those west of 87.5° W. longitude are regulated by the MMS (**Figure 1-2**). In the OCS areas under MMS jurisdiction, MMS regulations at 30 CFR 250 apply.

The 1990 Clean Air Act Amendments (CAAA) (Public Law No. 101-549) required MMS to conduct a study to evaluate cumulative, onshore, air quality non-attainment area, impacts from OCS petroleum resource development in the GOM. Subsequent to the completion of the air quality impacts study in 1995, the DOI Secretary consulted with the USEPA Administrator and determined no new air quality requirements were necessary for the area under MMS jurisdiction.

The MMS air quality regulations are codified in 30 CFR 250 Subpart C. These regulations are used to assess and control OCS emissions that may impact air quality in onshore areas. In accordance with MMS air quality regulations, MMS applies defined criteria to determine which OCS plans require an air quality review, and performs an impact-based analysis, on the selected plans, to determine whether the emission source would potentially cause a significant onshore impact. Should the emission source be deemed significant, requiring air quality modeling, the USEPA preferred model, the steady-state Gaussian, Offshore and Coastal Dispersion (OCD) model should be used.

The Clean Water Act

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972. The CWA establishes the basic structure for regulating discharges of pollutants to waters of the U.S. Under the CWA, it is unlawful for any person to discharge any pollutant from a point source into navigable waters without a National Pollution Discharge Elimination System (NPDES) permit. Under Sections 301 and 304 of the CWA, USEPA issues technology-based effluent guidelines that establish discharge standards based on treatment technologies that are available and economically achievable. Permits that meet or exceed the guidelines and standards are issued. Initially, the CWA targeted point source discharges from industrial and municipal sources. More recently, efforts to address watershed issues and nonpoint-source discharges such as urban and agricultural runoff have been implemented.

All waste streams generated from offshore oil and gas activities are regulated by the USEPA, primarily by general permits. The USEPA may not issue a permit for a discharge into ocean waters unless the discharge complies with the guidelines established under Section 403(c) of the CWA. These guidelines are intended to prevent degradation of the marine environment and require an assessment of the effect of the proposed discharges on sensitive biological communities and aesthetic, recreational, and economic values. The most recent effluent guidelines for the oil and gas extraction point-source category were published in 1993. The USEPA also published new guidelines for the discharge of synthetic-based drilling fluids (SBF) on January 22, 2001.

Within the GOM, USEPA Region 6 has jurisdiction over the all of the WPA and the majority of the CPA. The USEPA Region 4 has jurisdiction over the eastern portion of the GOM, including all of the EPA and part of the CPA off the coasts of Alabama and Mississippi. Each region has promulgated general permits for discharges that incorporate the 1993 effluent guidelines as a minimum. In some instances, a site-specific permit is required.

Discharges to the GOM must meet the requirements of the permit that is in effect. In USEPA Region 6, the permit (GMG290000) became effective on November 6, 2004, and will expire on November 5, 2007. A three-year permit was written so that any new information that could assist in the reduction of the hypoxic zone could be included. In USEPA Region 4, the new permit (GMG460000) became effective on January 1, 2005, and will expire on December 31, 2009.

Other sections of the CWA also apply to offshore oil and gas activities. Section 404 of the CWA requires a Corps of Engineers (COE) permit for the discharge or deposition of dredged or fill material in all the waters of the U.S. Approval by the COE, with consultation from other Federal and State agencies, is also required for installing and maintaining pipelines in coastal areas of the GOM. Section 303 of the CWA provides for the establishment of water quality standards that identify a designated use for waters (e.g., fishing/swimming). States have adopted water quality standards for ocean waters within their jurisdiction (waters of the territorial sea that extend out to 3 nmi off Louisiana, Mississippi, and Alabama, and 3 leagues off Texas and Florida). Section 402(b) of the CWA authorizes USEPA approval of State permit programs for discharges from point sources.

Harmful Algal Bloom and Hypoxia Research and Control Act

The Harmful Algal Bloom and Hypoxia Research and Control Act (P.L. 105-383) was passed in 1998 in response to a surge in blooms nation-wide which resulted in fish kills, beach and shellfish bed closures, and manatee deaths. The 2004 amendments include a periodic review to evaluate program effectiveness. The act required an assessment of the causes and consequences of hypoxia in the GOM and the development of a plan to reduce hypoxia. Six reports commissioned by the White House Committee on Environment and Natural Resources comprise the assessment. The Mississippi River GOM Watershed Nutrient Task Force developed the Action Plan with the goal to halve the size of the hypoxic zone in 15 years. The original goal aimed primarily at nitrogen reduction. Recently the contribution of phosphorous has received additional attention. As upstream industrial, and urban and agricultural sources are quantified and remedial programs discussed, produced water discharges from offshore oil and gas have also been suggested as a possible source of nutrients that require further investigation.

The Oil Pollution Act

The Oil Pollution Act of 1990 (OPA or OPA 90) (33 U.S.C. 2701 *et seq*.) is comprehensive legislation that includes, in part, provisions to (1) improve oil-spill prevention, preparedness, and response capability; (2) establish limitations on liability for damages resulting from oil pollution; and (3) implement a fund for the payment of compensation for such damages.

The OPA, in part, revised Section 311 of the CWA to expand Federal spill-response authority; increase penalties for spills; establish U.S. Coast Guard (USCG), prepositioned, oil-spill response equipment sites; require vessel and facility response plans; and provide for interagency contingency plans. Many of the statutory changes required corresponding revisions to the National Oil and Hazardous Substances Pollution Contingency Plan.

If a spill or substantial threat of a spill of oil or a hazardous substance from a vessel, offshore facility, or onshore facility is considered to be of such a size or character to be a substantial threat to the public health or welfare of the U.S., under provisions of the Act, the President (through the USCG) now has the authority to direct all Federal, State, and private actions to remove a spill or to mitigate or prevent the threat of the spill. Potential impacts from spills of oil or a hazardous substance to fish, shellfish, wildlife, other natural resources, or the public and private beaches of the U.S. would be an example of the degree or type of threat considered to be of such a size or character to be a substantial threat to the U.S. public health or welfare. In addition, the USCG's authority to investigate marine accidents involving foreign tankers was expanded to include accidents in the Exclusive Economic Zone (EEZ). The Act also established USCG oil-spill, district response groups (including equipment and personnel) in each of the 10 USCG districts, with a national response unit, the National Strike Force Coordination Center, located in Elizabeth City, North Carolina.

The OPA strengthened spill planning and prevention activities by providing for the establishment of interagency spill contingency plans for areas of the U.S. To achieve this goal, Area Committees composed of qualified Federal, State, and local officials were created to develop Area Contingency Plans. The OPA mandates that contingency plans address the response to a "worst case" oil spill or a substantial threat of such a spill. It also required that vessels and both onshore and offshore facilities have response plans approved by the President. These plans were required to adhere to specified requirements, including the demonstration that they had contracted with private parties to provide the personnel and equipment necessary to respond to or mitigate a "worst case" spill. In addition, the Act provided for increased penalties for violations of statutes related to oil spills, including payment of triple costs by persons who fail to follow contingency plan requirements.

The Act further specifies that vessel owners, not cargo owners, are liable for spills and raises the liability limits from $150 (dollars) per gross ton to $1,200 per gross ton for vessels. The maximum liability for offshore facilities is set at $75 million plus unlimited removal costs; liability for onshore facilities or a deepwater port is set at $350 million. Willful misconduct, violation of any Federal operating or safety standard, failure to report an incident, or refusal to participate in a cleanup subjects the spiller to unlimited liability under provisions of the Act.

Pursuant to the Act, double hulls are required on all newly constructed tankers. Double hulls or double containment systems are required on all tank vessels less than 5,000 gross tons (i.e., barges). Since 1995, existing single-hull tankers are being phased out based on size and age.

An Interagency Coordinating Committee on Oil Pollution Research was established by the provisions of the Act and tasked with submitting a plan for the implementation of an oil-pollution research, development, and demonstration program to Congress. The plan was submitted to Congress in April 1992. This program addressed, in part, an identification of important oil-pollution research gaps, an establishment of research priorities and goals, and an estimate of the resources and timetables necessary to accomplish the identified research tasks. In 1992, the program plan was also provided to the Marine Board of the National Research Council for review and comment as required by OPA 90. Upon review, the Marine Board recommended that the plan be revised using a framework that addresses spill prevention, human factors, and field testing demonstration of developed response technology. This was accomplished in April, 1997.

In October 1991, Executive Order 12777 delegated the provisions of OPA to various departments and agencies within the U.S. Government, including the USCG, USEPA, U.S. Department of Transportation (USDOT or DOT), and DOI. The Secretary was delegated Federal Water Pollution Control Act authority over offshore facilities and associated pipelines (except deepwater ports) for all Federal and State waters. The Secretary's functions under the Executive Order include spill prevention, Oil Spill Contingency Plans (OSCP's), equipment, financial responsibility certification, and civil penalties.

The Oil Spill Liability Trust Fund (OSLTF), authorized under OPA and administered by the USCG, is available to pay for removal costs and damages not recovered from responsible parties. The Fund provides up to $1 billion per incident for cleanup costs and other damages. The OSLTF was originally established under Section 9509 of the Internal Revenue Code of 1986. It was one of several similar Federal trust funds funded by various levies set up to provide for the costs of water pollution. The OPA generally consolidated the liability and compensation schemes of these prior, Federal oil-pollution laws and authorized the use of the OSLTF, which consolidated the funds supporting those regimes. Those prior laws included the Federal Water Pollution Control Act, Trans-Alaska Pipeline Authorization Act, Deepwater Port Act, and OCSLA. On February 20, 1991, the National Pollution Funds Center (NPFC) was commissioned to serve as fiduciary agent for the OSLTF.

The OPA 90 provides that parties responsible for offshore facilities demonstrate, establish, and maintain oil-spill financial responsibility (OSFR) for those facilities. The OPA 90 replaced and rescinded the OCSLA OSFR requirements. Executive Order 12777 assigned the OSFR certification function to the DOI; the Secretary, in turn, delegated this function to MMS.

The minimum amount of OSFR that must be demonstrated is $35 million for covered offshore facilities (COF's) located on the OCS and $10 million for COF's located in State waters. A COF is any structure and all of its components, equipment, pipeline, or device (other than a vessel or other than a pipeline or deepwater port licensed under the Deepwater Port Act of 1974) used for exploring for, drilling for, or producing oil or for transporting oil from such facilities. The regulation provides an exemption for persons responsible for facilities having a potential worst-case oil spill of 1,000 barrel (bbl) or less, unless the risks posed by a facility justify a lower threshold volume.

The Secretary of Transportation has authority for vessel oil-pollution financial responsibility, and the USCG regulates the oil-spill financial responsibility program for vessels. A mobile offshore drilling unit (MODU) is classified as a vessel. However, a well drilled from a MODU is classified as an offshore facility under this rule.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 U.S.C. 9601 *et seq*.), modified by the 1986 Superfund Amendments and Reauthorization Act (SARA) and Section 1006 of OPA 90, requires the promulgation of regulations for the assessment of natural resource damages from oil spills and hazardous substances. These Acts provide for the designation of trustees who determine resource injuries, assess natural resource damages (including the costs of assessing damages), present claims, recover damages, and develop and implement plans for the restoration, rehabilitation, replacement, or acquisition of the equivalent of the injured natural resources under the trusteeship.

The DOI was given the authority under CERCLA to develop regulations and procedures for the assessment of damages for natural resource injuries resulting from the release of a hazardous substance or oil spills (Natural Resource Damage Assessment (NRDA) Regulations). These rulemakings are all codified at 43 CFR 11. The CERCLA specified two types of procedures to be developed: type "A" procedures for simplified, standard assessments requiring minimal field observations in cases of minor spills or releases in certain environments; and type "B" site-specific procedures for detailed assessments for individual cases.

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 *et seq*.) provides a framework for the safe disposal and management of hazardous and solid wastes. The OCS wastes taken to shore are regulated under RCRA. The USEPA has exempted many oil and gas wastes from coverage under the hazardous wastes regulations of RCRA. Exempt wastes (exploration and production (E&P) waste) include those generally coming from an activity directly associated with the exploration, drilling, production, or processing of a hydrocarbon product. Therefore, most oil and gas wastes taken onshore are not regulated by the Federal Government but by various Gulf States' programs. It is occasionally possible for a RCRA exempt E&P waste to fail a State's E&P waste disposal regulations. If wastes generated on the OCS are not exempt and are hazardous, the wastes must be transported to shore for disposal at a hazardous waste facility.

Marine Plastic Pollution Research and Control Act

The Marine Plastic Pollution Research and Control Act of 1987 (MPPRCA) (33 U.S.C. 1901 *et seq*.) implements Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL). Under provisions of the law, all ships and watercraft, including all commercial and recreational fishing vessels, are prohibited from dumping plastics at sea. The law also severely restricts the legality of dumping other vessel-generated garbage and solid-waste items both at sea and in U.S.

navigable waters. The USCG is responsible for enforcing the provisions of this law and has developed final rules for its implementation (33 CFR 151, 155, and 158), calling for adequate trash reception facilities at all ports, docks, marinas, and boat-launching facilities.

The GOM has received "Special Area" status under MARPOL, thereby prohibiting the disposal of all solid waste into the marine environment. Fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease are required to develop waste management plans and to post placards reflecting discharge limitations and restrictions.

Waste Management Plans require oil and gas operators to describe procedures for collecting, processing, storing, and discharging garbage and to designate the person who is in charge of carrying out the plan. The MMS regulations explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items must be marked in a durable manner with the owner's name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use. These rules also apply to all oceangoing ships of 12 m (39 feet (ft)) or more in length that are documented under the laws of the U.S. or numbered by a State and that are equipped with a galley and berthing. Placards noting discharge limitations and restrictions, as well as penalties for noncompliance, apply to all boats and ships 8 m (26 ft) or more in length. Furthermore, the Shore Protection Act of 1988 (33 U.S.C. 2601 *et seq*.) requires ships transporting garbage and refuse to assure that the garbage and refuse is properly contained on-board so that it will not be lost in the water from inclement wind or weather conditions.

National Fishing Enhancement Act

The National Fishing Enhancement Act of 1984 (33 U.S.C. 2601 *et seq*.), also known as the Artificial Reef Act, establishes broad artificial reef development standards and a national policy to encourage the development of artificial reefs that will enhance fishery resources and commercial and recreational fishing. It mandated that a long-term artificial reef plan be developed. The Secretary of Commerce provided leadership in developing the National Artificial Reef Plan (NARP) that identifies the roles of Federal, State, local and private agencies in the development of artificial reefs. It provides national guidelines on the siting, materials, design, regulatory requirements, construction, management, and liability of artificial reefs. It cites key documents, provides the best existing information, and lists future research needs. The Secretary of the Army issues permits to responsible applicants for reef development projects in accordance with the NARP, as well as regional, State, and local criteria and plans. The law also limits the liability of reef developers complying with permit requirements and includes the availability of all surplus Federal ships for consideration as reef development materials.

Fishermen's Contingency Fund

Final regulations for the implementation of Title IV of the OCSLA, as amended (43 U.S.C. 1841-1846), were published in the *Federal Register* on January 24, 1980 (50 CFR 296). The OCSLA, as amended, established the Fishermen's Contingency Fund (not to exceed $2 million) to compensate commercial fishermen for actual and consequential damages, including loss of profit due to damage or loss of fishing gear by various materials and items associated with oil and gas exploration, development, or production on the OCS. This Fund, administered by the Financial Services Division of NOAA Fisheries Service, mitigates most losses suffered by commercial fishermen due to OCS oil and gas activities.

As required in the OCSLA, nine area accounts have been established—five in the GOM, one in the Pacific, one in Alaska, and two in the Atlantic. The five Gulf accounts cover the same areas as the five MMS GOM OCS Region Districts. Each area account is initially funded at $100,000 and cannot exceed this amount. The accounts are initiated and maintained by assessing holders of leases, pipeline rights-of-way and easements, and exploration permits. These assessments cannot exceed $5,000 per operator in any calendar year.

The claims eligible for compensation are generally contingent upon the following: (1) damages or losses must be suffered by a commercial fisherman; and (2) any actual or consequential damages, including loss of profit, must be due to damages or losses of fishing gear by items or obstructions related to OCS oil and gas activities. Damages or losses that occur in non-OCS waters may be eligible for compensation if the item(s) causing damages or losses are associated with OCS oil and gas activities.

Ineligible claims for compensation are generally (1) damages or losses caused by items that are attributable to a financially responsible party; (2) damages or losses caused by negligence or fault of the commercial fishermen; (3) occurrences before September 18, 1978; (4) claims of damages to, or losses of, fishing gear exceeding the replacement value of the fishing gear; (5) claims for loss of profits in excess of 6 months, unless supported by records of the claimant's profits during the previous 12 months; (6) claims or any portions of damages or losses claimed that will be compensated by insurance; (7) claims not filed within 60 days of the event of the damages or losses; and (8) damages or losses caused by natural obstructions or obstructions unrelated to OCS oil and gas activities.

There are several requirements for filing claims, including one that a report stating, among other things, the location of the obstruction, must be made within 5 days after the event of the damages or losses; this 5-day report is required to gain presumption of causation. A detailed claim form must be filed within 60 days of the event of the damages or losses. The specifics of this claim are contained in 50 CFR 296. The claimant has the burden of establishing all the facts demonstrating eligibility for compensation, including the identity or nature of the item that caused the damages or losses and its association with OCS oil and gas activity.

Damages or losses are presumed to be caused by items associated with OCS oil and gas activities provided the claimant establishes that (1) the commercial fishing vessel was being used for commercial fishing and was located in an area affected by OCS oil and gas activities; (2) the 5-day report was filed; (3) there is no record in the most recent Department of Commerce's National Oceanic and Atmospheric Administration/National Ocean Service (NOAA/NOS) nautical charts or weekly USCG Notice to Mariners of an obstruction in the immediate vicinity; and (4) no proper surface marker or lighted buoy marked the obstruction. Damages or losses occurring within a one-quarter-mile radius of obstructions recorded on charts, listed in the Notice to Mariners, or properly marked are presumed to involve the recorded obstruction.

Ports and Waterways Safety Act

The Ports and Waterways Safety Act (33 U.S.C. 1223) of 1972 authorizes the USCG to designate safety fairways, fairway anchorages, and traffic separation schemes (TSS's) to provide unobstructed approaches through oil fields for vessels using GOM ports. The USCG provides listings of designated fairways, anchorages, and TSS's in 33 CFR 166 and 167, along with special conditions related to oil and gas production in the GOM. In general, no fixed structures, such as platforms, are allowed in fairways. Temporary underwater obstacles such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs may be placed in a fairway under certain conditions. Fixed structures may be placed in anchorages, but the number of structures is limited by spacing.

A TSS is a designated routing measure that is aimed at the separation of opposing streams of traffic by appropriate means and by the establishment of traffic lanes (33 CFR 167.5). The Galveston Bay TSS and precautionary areas is the only TSS established in the GOM. There is no TSS in the CPA or EPA.

Marine and Estuarine Protection Acts

The Sanctuaries and Reserves Division, NOS, NOAA, of the Department of Commerce (DOC), administers the National Marine Sanctuary and National Estuarine Research Reserve programs. The marine sanctuary program was established by the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), and the estuarine research reserve program was established by the Coastal Zone Management Act of 1972.

Marine sanctuaries and estuarine research reserves are designed and managed to meet the following goals, among others:

- enhance resource protection through the implementation of a comprehensive, long-term management plan tailored to the specific resources;
- promote and coordinate research to expand scientific knowledge of sensitive marine resources and improve management decision making;

- enhance public awareness, understanding, and wise use of the marine environment through public interpretive and recreational programs; and
- provide for optimum compatible public and private use of special marine areas.

The Congress declared that ocean dumping in the territorial seas or the contiguous zone of the U.S. would be regulated under MPRSA (33 U.S.C. 1401 *et seq*.). Under 40 CFR 228, pursuant to Section 103 of the MPRSA, sites and times for ocean dumping of dredged and non-dredged materials were designated by USEPA after a determination that such dumping will not unreasonably degrade or endanger human health, welfare, or the marine environment. The EIS's on these disposal sites describe impacts that are expected to occur over a period of 25 years. Under 33 U.S.C. 1413 (33 CFR 324), the COE reviews applications for permits to transport dredged and nondredged materials for the purpose of dumping it in ocean waters. On December 31, 1981, 33 U.S.C. 1412a mandated the termination of ocean dumping of sewage sludge and industrial waste.

Marine Protection, Research, and Sanctuaries Act

The MPRSA of 1972 established the National Marine Sanctuary Program, which is administered by NOAA of the DOC. The Flower Garden Banks National Marine Sanctuary (FGBNMS), which was designated in 1992, is the only sanctuary that exists in the northern GOM. The DOI has taken action to protect the biological resources of the sanctuary from damage due to oil and gas exploration and development activities. The MMS has established a "No Activity Zone" around the sanctuary and has established other operational restrictions as described in the Topographic Features Stipulation. Stetson Bank was added to the FGBNMS in 1996 and is protected from oil and gas activities by a "No Activity Zone." Whole blocks and portions of blocks that lie within the boundaries of FGBNMS at the East and West Flower Garden Banks and Stetson Bank are excluded from leasing.

National Estuarine Research Reserves

The National Estuarine Research Reserve System is a network of protected areas established for long-term research, education, and stewardship. This partnership program between NOAA and coastal states has established five reserves (Grand Bay National Estuarine Research Reserve in Mississippi, Weeks Bay National Estuarine Research Reserve in Alabama, Rookery Bay National Estuarine Research Reserve and Apalachicola National Estuarine Research Reserve in Florida, and Mission-Aransas Reserve in Texas) in the GOM.

Grand Bay National Estuarine Research Reserve covers about 8,400 ac (7,470 ha) in Jackson County, Mississippi. Located between Pascagoula and the Alabama State line, it contains diverse habitats that support several rare or endangered plants and animals. The reserve's fishery resources include oysters, fish, and shrimp. The area also has recreational resources and archaeological sites.

Weeks Bay National Estuarine Research Reserve covers a small estuary of approximately 3,000 ac (1,215 ha) in Baldwin County, Alabama. Weeks Bay is a shallow open bay with an average depth of less than 4.9 ft (1.5 m) and extensive vegetated wetland areas. The bay receives waters from the spring-fed Fish and Magnolia Rivers and connects with Mobile Bay through a narrow opening.

Rookery Bay National Estuarine Research Reserve, at more than 8,500 ac (3,440 ha), preserves a large mangrove-filled bay and two creeks, along with their drainage corridors. Management of the sanctuary is performed by the Florida Department of Environmental Protection, The Nature Conservancy, and the National Audubon Society. This unique management structure was created when the two private organizations granted a dollar-per-year, 99-year lease of the land to the State. Federal and State funds will add additional key acreage to the existing core area. The diversity of the area's fauna can be recognized by the porpoises that feed there and the bald eagles and white-tailed deer that make Rookery Bay their permanent residence. Within the Sanctuary is a marine laboratory, which, even before the establishment of the sanctuary, provided data used in important coastal management decisions — a primary objective of Congress in establishing the estuarine research-reserve program.

At about 190,000 ac (76,890 ha), the Apalachicola National Estuarine Research Reserve is one of the largest remaining naturally functioning ecosystems in the Nation, and it is also the first sanctuary on the mouth of a major navigable river. Its establishment served to promote improved cooperation concerning river navigation among the States of Florida, Alabama, and Georgia. The major business activity of Apalachicola, which is adjacent to the sanctuary, centers around the oyster industry. It is expected that the sanctuary will benefit this and other fishing industries by protecting the environment and by providing research information that will help assure the continued productivity of the bay/river ecosystem. A FWS refuge and a State park, representing a unique cooperative effort at ecosystem protection, exist within the boundaries of the reserve.

The proposed Mission-Aransas Reserve covers 185,708 ac (75,153 ha) in Aransas and Refugio Counties, Texas. It is a contiguous complex of wetland, terrestrial, and marine environments. The land is mostly coastal prairie with unique oak motte habitats. The wetlands include riparian habitat and fresh and saltwater marshes. Within the water areas, the bays are large, open, and include extensive tidal flats, seagrass meadows, mangroves, and oyster reefs. These unique and diverse estuarine habitats in the Western GOM support a host of endangered and threatened species, including the endangered whooping crane.

The National Estuary Program

In 1987, an amendment to the Clean Water Act, known as the Water Quality Act (P.L. 100-4), established the National Estuary Program (NEP). The purpose of the NEP is to identify nationally important estuaries, to protect and improve their water quality, and to enhance their living resources. Under the NEP, which is administered by the USEPA, comprehensive management plans are generated to protect and enhance environmental resources. The governor of a state may nominate an estuary for the Program and request that a Comprehensive Conservation and Management Plan (CCMP) be developed for an estuary. Representatives from Federal, State, and interstate agencies; academic and scientific institutions; and industry and citizen groups work during a 5-year period to define objectives for protecting the estuary, to select the chief problems to be addressed in the Plan, and to ratify a pollution control and resource management strategy to meet each objective. Strong public support and subsequent political commitments are needed to accomplish the actions called for in the Plan; hence, the 5-year time period to develop the strategies. A total of 22 estuaries have been selected for the Program, 7 of which are in the GOM: Sarasota Bay, Charlotte Harbor, and Tampa Bay in Florida; Mobile Bay in Alabama; the Barataria-Terrebonne Estuarine Complex in Louisiana; and Galveston Bay and Coastal Bend Bay and Estuaries in Texas.

Executive Order 11990 (May 24, 1977), Protection of Wetlands

Executive Order 11990 establishes that each Federal agency shall provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities. The Executive Order applies to the following Federal activities: managing and disposing of Federal lands and facilities; providing federally undertaken, financed, or assisted construction and improvements; and conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

Coastal Barrier Resources Act

The Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 *et seq*.) of 1982 established that undeveloped coastal barriers, per the Act's definition, may be included in a Coastal Barrier Resource System (CBRS).

The CBRA prohibits all new Federal expenditures and financial assistance within the CBRS, with certain specific exceptions, including energy development. The purpose of this legislation was to end the Federal Government's encouragement for development on barrier islands by withholding Federal flood insurance for new construction of or substantial improvements to structures on undeveloped coastal barriers.

The National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended (16 U.S.C. 470 *et seq*.), states that any Federal agency, before approving federally permitted or federally funded undertakings, must take into consideration the effect of that undertaking on any property listed on, or eligible for, the National Register of Historic Places. Implied in this legislation and Executive Order 11593 is that an effort be made to locate such sites before development of an area. Section 101(b)(4) of NEPA states that it is the continuing responsibility of the Federal Government to preserve important historic and cultural aspects of our natural heritage. In addition, Section 11(g)(3) of the OCSLA, as amended, states that "exploration (oil and gas) will not . . . disturb any site, structure, or object of historical or archaeological significance."

The NHPA provides for a National Register of Historic Places to include districts, sites, buildings, structures, and objects noteworthy in American history, architecture, archaeology, and culture. These items may bear National, State, or local significance. The NHPA provides funding for the State Historic Preservation Officer and his staff to conduct surveys and comprehensive preservation planning, establishes standards for State programs, and requires States to establish mechanisms for certifying local governments to participate in the National Register nomination and funding programs.

Section 106 of the Act requires that Federal agencies having direct or indirect jurisdiction over a proposed Federal, federally assisted, or federally licensed undertaking, prior to approval of the expenditure of funds or the issuance of a license, take into account the effect of the undertaking on any district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places, and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment with regard to the undertaking. This Council, appointed by the President, has implemented procedures to facilitate compliance with this provision at 36 CFR 800.

Section 110 of the NHPA directs the heads of all Federal agencies to assume responsibility for the preservation of National Register listed or eligible historic properties owned or controlled by their agency as well as those not under agency jurisdiction and control but are potentially affected by agency actions. Federal agencies are directed to locate, inventory, and nominate properties to the National Register, to exercise caution to protect such properties, and to use such properties to the maximum extent feasible. Other major provisions of Section 110 include documentation of properties adversely affected by Federal undertakings, the establishment of trained Federal preservation officers in each agency, and the inclusion of the costs of preservation activities as eligible agency project costs.

A Section 106 review refers to the Federal review process designed to ensure that historic properties are considered during Federal project planning and execution. The review process is administered by the Advisory Council on Historic Preservation, an independent Federal agency, together with the State Historic Preservation Office.

Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 401 *et seq*.) prohibits the unauthorized obstruction or alteration of any navigable water of the U.S. The construction of any structure in or over any navigable water of the U.S., the excavating from or depositing of dredged material or refuse in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters is unlawful without prior approval from the COE. The legislative authority to prevent inappropriate obstructions to navigation was extended to installations and devices located on the seabed to the seaward limit of the OCS by Section 4(e) of the OCSLA of 1953, as amended.

Executive Order 12898: Environmental Justice

The environmental justice policy, based on Executive Order 12898 of February 11, 1994, requires agencies to incorporate analysis of the environmental and health effects of their proposed programs on minorities and low-income populations and communities into NEPA documents. The MMS's existing NEPA process invites participation by all groups and communities in the development of its proposed actions, alternatives, and potential mitigation measures. Scoping and review for the EIS is an open process that provides an opportunity for all participants, including minority and low-income populations, to raise new expressions of concern that can be addressed in the EIS. Impacts to socioeconomic conditions, commercial fisheries, air quality, and water quality are considered in the analysis of effects of the proposed actions on local populations or resources used by local groups including minority and low-income groups.

Occupational Safety and Health Act

The Occupational Safety and Health Act of 1970 (29 U.S.C. 651-678) was enacted to assure, to the extent possible, safe and healthful working conditions and to preserve our human resources. The Act encourages employers and employees to reduce occupational safety and health hazards in their places of employment and stimulates the institution of new programs and the perfection of existing programs for providing safe and healthful working conditions. The Act established the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the National Advisory Committee on Occupational Safety and Health (NACOSH). The NIOSH is responsible for conducting research and making recommendations for the prevention of work-related injury and illness. The OSHA is responsible for developing and enforcing workplace safety and health regulations. The NACOSH advises the Secretaries of Labor and Health and Human Services on occupational safety and health programs and policies.

The Act empowers the Secretary of Labor or his representative to enter any factory, plant, establishment, workplace, or environment where work is performed by employees and to inspect and investigate during regular working hours and at other reasonable times any such place of employment and all pertinent conditions and equipment therein. If, upon inspection, the Secretary of Labor or authorized representative believes that an employer has violated provisions of the Act, the employer shall be issued a citation and given 15 days to contest the citation or proposed assessment of penalty.

Energy Policy Act

The Energy Policy Act of 2005 (P.L. 109-58) encourages increased domestic production of oil and natural gas, grants MMS new authority for Federal offshore alternate energy uses, and requires a comprehensive inventory of oil and gas resources on the OCS.

The Act grants MMS new responsibilities over Federal offshore renewable energy and related uses on the OCS. Section 388 of the Act provides an initiative to facilitate increased renewable energy production on the OCS.

Section 388 gives the Secretary the authority to

- grant leases, easements, or rights-of way for renewable energy-related uses on Federal OCS lands,
- act as a lead agency for coordinating the permitting process with other Federal agencies,
- monitor and regulate those facilities used for renewable energy production and energy support services; and
- establish an interagency comprehensive digital mapping effort to assist in decisionmaking related to renewable energy activity.

Section 388 clarifies the Secretary's authority to allow an offshore oil and gas structure, previously permitted under the OCSLA, to remain in place after oil and gas activities have ceased in order to allow the use of the structure for other energy and marine-related activities. This authority provides opportunities to extend the life of facilities for non-oil and gas purposes, such as research, renewable energy production, aquaculture, etc., before being removed.

Section 388 does not authorize any leasing, exploration, or development activities for oil or natural gas. Congressional moratoria and administrative withdrawals in effect remain unchanged.

The Energy Policy Act created the Coastal Impact Assistance Program (CIAP) by amending Section 31 of the OCSLA. Under the provisions of the Act, the authority and responsibility for the management of CIAP is vested in the Secretary of DOI. The Secretary has delegated this authority and responsibility to MMS.

Under Section 384, MMS shall disburse $250 million for each fiscal year (FY) 2007 through 2010 to eligible producing States and coastal political subdivisions (CPS's). The MMS shall determine CIAP funding allocations to States and CPS's using the formulas mandated by the Act (Section 31(b)), which requires a minimum annual allocation of 1 percent to each State and provides that 35 percent of each State's share shall be allocated directly to its CPS's. States eligible to receive funding are Alabama, Alaska, California, Louisiana, Mississippi, and Texas; 67 CPS's are eligible to receive CIAP funding.

The Energy Policy Act (Section 31(d)(1)) stipulates that a State or CPS shall use CIAP funds only for one or more of the following authorized uses:

- projects and activities for the conservation, protection, or restoration of coastal areas, including wetland;
- mitigation of damage to fish, wildlife, or natural resources;
- planning assistance and the administrative costs of complying with CIAP;
- implementation of a federally approved marine, coastal, or comprehensive conservation management plan; and
- mitigation of the impact of OCS activities through funding of onshore infrastructure projects and public service needs.

In order to receive CIAP funds, States are required to submit a coastal impact assistance plan (Plan) that MMS must approve prior to disbursing any funds; all funds shall be disbursed through a grant process. Pursuant to the Act, a State must submit its Plan no later than July 1, 2008. Section 357 of the Act, entitled "Comprehensive Inventory of OCS Oil and Natural Gas Resources," calls for MMS to conduct a comprehensive inventory of the estimated oil and natural gas resources on the OCS, including moratoria areas. The Act requires the use of "any available technology, except drilling, but including 3-D seismic surveys." The first report to Congress was required to be submitted within 6 months of enactment and will be publicly available and updated at least every 5 years. To respond to this statutory directive, MMS published *Report to Congress: Comprehensive Inventory of U.S. OCS Oil and Natural Gas Resources* in February 2006.

1.4. PRELEASE PROCESS

Scoping for this EIS was conducted in accordance with CEQ regulations implementing NEPA. Scoping provides those with an interest in the OCS Program an opportunity to provide comments on the proposed actions. In addition, scoping provides MMS an opportunity to update the GOM OCS Region's environmental and socioeconomic information base. The scoping process officially commenced on March 7, 2006, with the publication of the Notice of Intent to Prepare an EIS (NOI) and Scoping Meetings in the *Federal Register*. Additional public notices were distributed via local newspapers, the U.S. Postal Service, and the Internet. A 45-day comment period was provided; it closed on April 21, 2006. Federal, State, and local governments, along with other interested parties, were invited to send written comments to the GOM OCS Region on the scope of the EIS. Formal scoping meetings were held during March and April 2006 in Texas, Louisiana, Alabama, and Florida. Comments were received in response to the NOI and four scoping meetings from Federal, State, local government agencies, interest groups, industry, businesses, and the general public on the scope of the EIS, significant issues that should be addressed, alternatives that should be considered, and mitigation measures. All scoping comments received were considered in the preparation of the Draft EIS. The comments (both verbal and written) have been summarized in **Chapter 5.3**, Development of the Draft EIS.

The MMS also conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for the proposed lease sales and this EIS. Key agencies and organizations included NOAA Fisheries Service, FWS, U.S. Department of Defense (USDOD or DOD), USCG, USEPA, State Governors' offices, and industry groups.

Although the scoping process was formally initiated on March 7, 2006, with the publication of the NOI in the *Federal Register*, scoping efforts and other coordination meetings have proceeded and will continue to proceed throughout this NEPA process. Scoping and coordination opportunities are available during MMS's requests for information, comments, input, and review on other MMS NEPA documents.

On July 24, 2006, the Area Identification (Area ID) decision was made. One Area ID was prepared for all proposed lease sales. The Area ID is an administrative prelease step that describes the geographical area of the proposed actions (proposed lease sale areas) and identifies the alternatives, mitigating measures, and issues to be analyzed in the appropriate NEPA document. As mandated by NEPA, this EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments.

The MMS will send copies of the Draft EIS for review and comment to public and private agencies, interest groups, and local libraries. To initiate the public review and comment period on the Draft EIS, MMS will publish a Notice of Availability (NOA) in the *Federal Register*. Additionally, public notices will be mailed with the Draft EIS and placed on the MMS Internet website (http://www.gomr.mms.gov). In accordance with 30 CFR 256.26, MMS will hold public hearings to solicit comments on the Draft EIS. The hearings will provide the Secretary with information from interested parties to help in the evaluation of potential effects of the proposed lease sales. Notices of the public hearings will be included in the NOA, posted on the MMS Internet website, and published in the *Federal Register* and local newspapers.

A consistency review will be performed and a Consistency Determination (CD) will be prepared for each affected State prior to each proposed lease sale. To prepare the CD's, MMS reviews each State's Coastal Zone Management Program (CZMP) and analyzes the potential impacts as outlined in this EIS, new information, and applicable studies as they pertain to the enforceable policies of each CZMP. Based on the analyses, the MMS Director makes an assessment of consistency, which is then sent to each State with the Proposed Notice of Sale (PNOS). If a State disagrees with MMS's CD, the State is required to do the following under CZMA: (1) indicate how the MMS presale proposal is inconsistent with their CZMP; (2) suggest alternative measures to bring the MMS proposal into consistency with their CZMP; or (3) describe the need for additional information that would allow a determination of consistency. Unlike the consistency process for specific OCS plans and permits, there is not a procedure for administrative appeal to the Secretary of Commerce for a Federal CD for presale activities. Either MMS or the State may request mediation. Mediation is voluntary and the DOC would serve as the mediator. Whether there is mediation or not, the final CD is made by DOI and is the final administrative action for the presale consistency process. Each Gulf State's CZMP is described in Appendix B.

The Final EIS will be published approximately 5 months prior to the first proposed sale, WPA Sale 204, which is scheduled for August 2007. To initiate the public review and 30-day minimum comment period on the Final EIS, MMS will publish a NOA in the *Federal Register*. The MMS will send copies of the Final EIS for review and comment to public and private agencies, interest groups, and local libraries. Additionally, public notices will be mailed with the Final EIS and placed on the MMS Internet website (http://www.gomr.mms.gov). After the end of the comment period, DOI will review the EIS and all comments received on the Final EIS.

A PNOS will become available to the public 4-5 months prior to a proposed sale. A notice announcing the availability of the PNOS appears in the *Federal Register* initiating a 60-day comment period. Comments received will be analyzed during preparation of the decision documents that are the basis for the Final Notice of Sale (FNOS), including lease sale configuration and terms and conditions.

If the decision by the Assistant Secretary of the Interior for Land and Minerals (ASLM) is to hold a proposed sale, a FNOS will be published in its entirety in the *Federal Register* at least 30 days prior to the sale date, as required by the OCS Lands Act.

This EIS will be the only NEPA review conducted for WPA Sale 204 and CPA Sale 205. A lease sale EA will be conducted for each of the subsequent proposed lease sales to address any relevant new information. Informal and formal consultations with other Federal agencies, the affected States, and the public will be carried out to assist in the determination of whether or not the information and analyses in this EIS are still valid. Specifically, Information Requests will be issued soliciting input on the subsequent proposed lease sales.

The EA will tier from this EIS and previous lease sale EA's, and will summarize and incorporate the material by reference. Because the EA will be prepared for a proposal that "is, or is closely similar to, one which normally requires the preparation of an EIS" (40 CFR 1501.4(e)(2)), the EA will be made available for public review for a minimum of 30 days prior to making a decision on the proposed lease sale. Consideration of the EA and any comments received in response to the Information Request will result in either a Finding of No New Significant Impact (FONNSI) or the determination that the preparation of a supplemental environmental impact statement (SEIS) is warranted. If the EA results in a FONNSI, the EA and FONNSI will be sent to the Governors of the affected States. The availability of the EA and FONNSI will be announced in the *Federal Register*. The FONNSI will become part of the documentation prepared for the decision on the Notice of Sale.

In some cases, the EA may result in a finding that it is necessary to prepare an SEIS (40 CFR 1502.9). Some of the factors that could justify a SEIS are a significant change in resource estimates, legal challenge on the EA/FONNSI, significant new information, significant new environmental issue(s), new proposed alternative(s), a significant change in the proposed action, or the analysis in this EIS is no longer deemed adequate.

If an SEIS is necessary, it will also tier from this EIS and will summarize and incorporate the material by reference. The analysis will focus on addressing the new issue(s) or concern(s) that prompted the decision to prepare the SEIS. The SEIS will include a discussion explaining the purpose of the SEIS, a description of the proposed action and alternatives, a comparison of the alternatives, a description of the affected environment for any potentially affected resources that are the focus of the SEIS and were not described in this EIS, an analysis of new impacts or changes in impacts from this EIS because of new information or the new issue(s) analyzed in the SEIS, and a discussion of the consultation and coordination carried out for the new issues or information analyzed in the SEIS.

1.5. Postlease Activities

The MMS is responsible for managing, regulating, and monitoring oil and natural gas exploration, development, and production operations on the Federal OCS to promote orderly development of mineral resources and to prevent harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations for oil, gas, and sulphur lease operations are specified in 30 CFR 250, 30 CFR 251, and 30 CFR 254.

Measures to mitigate potential impacts are an integral part of the OCS Program. These measures are implemented through lease stipulations, operating regulations, NTL's, and project-specific requirements or approval conditions. Mitigating measures address concerns such as endangered and threatened species, geologic and manmade hazards, military warning and ordnance disposal areas, air quality, oil-spill response planning, chemosynthetic communities, artificial reefs, operations in hydrogen sulfide (H_2S) prone areas, and shunting of drill effluents in the vicinity of biologically sensitive features. Standard mitigation measures in the GOM OCS include

- limiting the size of explosive charges used for structure removals;
- requiring placement explosive charges at least 15 ft below the mudline;
- requiring site-clearance procedures to eliminate potential snags to commercial fishing nets;
- establishment of No Activity and Modified Activity Zones around high-relief live bottoms;
- requiring remote-sensing surveys to detect and avoid biologically sensitive areas such as low-relief live bottoms, pinnacles, and chemosynthetic communities; and
- requiring coordination with the military to prevent multiuse conflicts between OCS and military activities.

The MMS issues NTL's to provide clarification, description, or interpretation of a regulation; guidelines on the implementation of a special lease stipulation or regional requirement; or convey administrative information. A detailed listing of current GOM OCS Region NTL's is available through the MMS, GOM OCS Region's Internet website at http://www.gomr.mms.gov/homepg/regulate/regs/ntls/ntl_lst.html or through the Region's Public Information Office at (504) 736-2519 or 1-800-200-GULF.

Conditions of approval are mechanisms to control or mitigate potential safety or environmental problems associated with proposed operations. Conditions of approval are based on MMS technical and environmental evaluations of the proposed operations. Comments from Federal and State agencies (as applicable) are also considered in establishing conditions. Conditions may be applied to any OCS plan, permit, right-of-use of easement, or pipeline right-of-way grant.

Some MMS-identified mitigation measures are implemented through cooperative agreements or efforts with the oil and gas industry and Federal and State agencies. These measures include the NOAA Fisheries Service Observer Program to protect marine mammals and sea turtles when OCS structures are removed using explosives, labeling of operational supplies to track sources of accidental debris loss, development of methods of pipeline landfall to eliminate impacts to barrier beaches, and semiannual beach cleanup events.

The following postlease activity descriptions apply only to the proposed lease sale area in the WPA and CPA.

Geological and Geophysical Activities

A geological and geophysical (G&G) permit must be obtained from MMS prior to conducting off-lease geological or geophysical exploration or scientific research on unleased OCS lands or on lands under lease to a third party (30 CFR 251.4 (a) and (b)). Geological investigations include various seafloor sampling techniques to determine the geochemical, geotechnical, or engineering properties of the sediments.

Ancillary activities are defined in 30 C.F.R. § 250.105 with regulations outlined in 30 C.F.R. § 250.207 through 250.210. Ancillary activities are activities conducted on lease and include geological and geophysical (G&G) explorations and development G&G activities; geological and high-resolution geophysical, geotechnical, archaeological, biological, physical oceanographic, meteorological, socioeconomic, or other surveys; or various types of modeling studies. The MMS issued NTL 2006-G12 to provide guidance and clarification on conducting ancillary activities in the MMS GOMR. Issued June 2, 2006, with an effective date of July 3, 2006, this NTL supersedes Letters to Lessees (LTL's) dated November 8, 1990, and June 21, 1991, regarding preliminary activities.

Per NTL 2006-G12, Operators must notify the MMS GOMR Regional Supervisor (RS), Field Operations (FO) in writing before conducting any of the following ancillary activities: a G&G exploration; a development G&G activity; a geophysical survey of any type in water depths 200 m (656 ft) or greater, or in the EPA of the GOM in any water depth where an airgun or airgun array is the seismic source; a geophysical survey of any type, independent of water depth, where explosives will be used as the energy source; a geotechnical evaluation involving piston or gravity coring or the recovery of sediment specimens by grab-sampling or similar technique; and any dredging or other geological or geophysical activity that disturbs the seafloor. This NTL also details the information requirements for each type of ancillary activity, the type and level of MMS review, and follow-up post survey report requirements.

Seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. Low-energy, high-resolution seismic surveys collect data on surficial geology used to identify potential shallow geologic or manmade hazards (e.g., faults or pipelines) for engineering and site planning for bottom-founded structures. The high-resolution surveys are also used to identify environmental and archaeological resources such as low-relief live-bottom areas, pinnacles, chemosynthetic community habitat, and shipwrecks. High-energy, deep-penetration, common-depth-point (CDP) seismic surveys obtain data about geologic formations thousands of feet below the seafloor. The two-dimensional (2D) and three-dimensional (3D) CDP data are used to map structure features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to map the extent of potential habitat for chemosynthetic communities. In some situations, a set of 3D surveys can be run over a time interval to produce a four-dimensional (4D), or "time-lapse," survey that could be used to characterize production reservoirs.

The MMS has completed a programmatic EA on Geological and Geophysical Exploration for Mineral Resources on the GOM OCS (USDOI, MMS, 2004). Upon receiving a complete G&G permit application, MMS conducts a categorical exclusion review (CER), an EA, or an EIS in accordance with the G&G PEA's conclusions, NEPA guidelines, and other applicable MMS policies. When required under an approved coastal zone management program, proposed G&G permit activities must receive State concurrence prior to MMS permit approval.

Exploration and Development Plans

To ensure conformance with the OCSLA, other laws, applicable regulations, and lease provisions, and to enable MMS to carry out its functions and responsibilities, formal plans (30 CFR 250.211 and 250.241) with supporting information must be submitted for review and approval by MMS before an operator may begin exploration, development, or production activities on any lease. Supporting environmental information, archaeological reports, biological reports (monitoring and/or live-bottom survey), and other environmental data determined necessary must be submitted with an OCS plan. This information provides the basis for an analysis of both offshore and onshore impacts that may occur as a result of the activities. The MMS may require additional specific supporting information to aid in the evaluation of the potential environmental impacts of the proposed activities. The MMS can require amendment of an OCS plan based on inadequate or inaccurate supporting information. The latest 30 CFR 250 Subpart B regulations were published in the *Federal Register* on August 30, 2005 (70 FR 167).

The OCS plans are reviewed by geologists, geophysicists, engineers, biologists, archaeologists, air quality specialists, oil-spill specialists, NEPA coordinators, and/or environmental scientists. The plans and accompanying information are evaluated to determine whether any seafloor or drilling hazards are present; that air and water quality issues are addressed; that plans for hydrocarbon resource conservation, development, and drainage are adequate; that environmental issues and potential impacts are properly evaluated and mitigated; and that the proposed action is in compliance with NEPA, CZMA, MMS operating regulations, and other requirements. Federal agencies, including the FWS, NOAA Fisheries Service, USEPA, the U.S. Navy, the U.S. Air Force, and the USCG, may be consulted if the proposal has the potential to impact areas under their jurisdiction. Each Gulf Coast State has a designated CZM agency that takes part in the review process. The OCS plans are also made available to the general public for comment through the MMS, GOM OCS Region's Public Information Office.

In response to increasing deepwater activities in the GOM, MMS developed a comprehensive strategy to address NEPA compliance and environmental issues in the deepwater areas. A key component of that strategy was the completion of a programmatic EA to evaluate the potential effects of the deepwater technologies and operations (USDOI, MMS, 2000). As a supplement to the EA, MMS prepared a series of technical papers that provide a summary description of the different types of structures that may be employed in the development and production of hydrocarbon resources in the deepwater areas of the GOM (Regg et al., 2000).

On the basis of the MMS reviews of the OCS plan, the findings of the proposal-specific CER, EA, or EIS, and other applicable MMS studies and NEPA documents, the OCS plan is approved or disapproved by MMS, or modification of the plan is required. Although very few OCS plans are ultimately disapproved, many must be amended prior to approval to fully comply with MMS operating regulations and requirements, or other Federal laws, to address reviewing agencies' concerns, or to avoid potential hazards or impacts to environmental resources.

On, January 23, 2003, MMS issued NTL 2003-G03, Remotely Operated Vehicle (ROV) Surveys in Deepwater. The NTL requires ROV surveys and reports in water depths greater than 400 m (1,312 ft). Eighteen grid areas were developed to ensure a broad and systematic analysis of deep water and to depict areas of biological similarity, primarily on the basis of benthic communities. The grid areas cover the WPA sale area and CPA sale area with the exception of the easternmost portion.

Operators must submit a ROV survey plan with each EP submitted in each grid area and with the Development Operations Coordination Document (DOCD) for the first surface structure proposed in each grid area. The following information must be included in a ROV survey plan:

- a statement that the operator is familiar with the ROV survey and reporting provisions of the NTL;
- a brief description of the survey the operator plans to conduct, including timeframes, proposed transects, and the equipment that will be used; and
- a statement that the operator will make biological and physical observations as described in the NTL and the ROV survey form during two periods of operations—prespudding (survey performed from the facility) and postdrilling (prior to facility removal).

A minimum of five surveys will be required for each grid area. The MMS will notify the operator whether or not to conduct the proposed ROV survey based on whether the grid area has already received adequate ROV survey coverage.

Exploration Plans

An EP must be submitted to MMS for review and decision before any exploration activities, except for preliminary activities, can begin on a lease. The EP describes exploration activities, drilling rig or vessel, proposed drilling and well-testing operations, environmental monitoring plans, and other relevant information, and includes a proposed schedule of the exploration activities. Guidelines and environmental information requirements for lessees and operators submitting an EP are addressed in 30 CFR 250.211 and further explained in NTL's 2006-G14 and 2006-G15. The NTL 2006-G14 provides guidance on information requirements and establishes the contents for OCS plans required by 30 CFR 250 Subpart B. This NTL, along with NTL 2006-G15, supersedes NTL 2003-G17. In the revised final Subpart B regulations, the contents of an EP are given. The NTL 2006-G15 provides guidance for submitting OCS plans to the MMS GOMR.

After receiving an EP, MMS performs technical and environmental reviews. The MMS evaluates the proposed exploration activities for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, State CZMA requirements, and other uses (e.g., military operations) of the OCS. The EP is reviewed for compliance with all applicable laws and regulations.

A CER or EA is prepared in support of the NEPA environmental review of the EP. The CER or EA is based on available information, which may include the geophysical report (for determining the potential for the presence of deepwater benthic communities); archaeological report; air emissions data; live-bottom survey and report; biological monitoring plan; and recommendations by the affected State(s), DOD, FWS (for selected plans under provisions of a DOI agreement), NOAA Fisheries Service, and/or internal MMS offices. As part of the review process, most EP's and supporting environmental information are sent to the affected State(s) for consistency certification review and concurrence under the States' approved Coastal Management Plans (CMP's).

After EP approval and prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD) (see *Wells* under *Permits and Applications* below).

Deepwater Operations Plans

In 1992, MMS formed an internal Deepwater Task Force to address technical issues and regulatory concerns relating to deepwater (greater than 1,000 ft or 305 m) operations and projects utilizing subsea technology. Based on the Deepwater Task Force's recommendation, an NTL (2000-N06) was developed, which required operators to submit a Deepwater Operations Plan (DWOP) for all operations in deep water (400 m (1,312 ft) or greater) and all projects using subsea technology. DeepStar, an industry-wide cooperative workgroup focused on deepwater regulatory issues and critical technology development issues, worked closely with the MMS Deepwater Task Force to develop the initial guidelines for the DWOP. The DWOP was established to address regulatory issues and concerns that were not addressed in the existing MMS regulatory framework, and it is intended to initiate an early dialogue between MMS and industry before major capital expenditures on deepwater and subsea projects are committed. Deepwater technology has been evolving faster than MMS's ability to revise OCS regulations; the DWOP was established through the NTL process, which provides for a more timely and flexible approach to keep pace with the expanding deepwater operations and subsea technology. On August 30, 2005, the DWOP requirements were incorporated into MMS operating regulations via revisions to 30 CFR 250 Subpart B.

The DWOP is intended to address the different functional requirements of production equipment in deep water, particularly the technological requirements associated with subsea production systems, and the complexity of deepwater production facilities. The DWOP provides MMS with information specific to deepwater equipment issues to demonstrate that a deepwater project is being developed in an acceptable manner as mandated in the OCSLA, as amended, and the MMS operating regulations at 30 CFR 250. The MMS reviews deepwater development activities from a total system perspective, emphasizing operational safety, environmental protection, and conservation of natural resources. The DWOP process is a phased approach that parallels the operator's state of knowledge about how a field will be developed. A DWOP outlines the design, fabrication, and installation of the proposed development/production system and its components. A DWOP will include structural aspects of the facility (fixed, floating, subsea); stationkeeping (includes mooring system); wellbore, completion, and riser systems; safety systems; offtake; and hazards and operability of the production system. The DWOP provides MMS with the information to determine that the operator has designed and built sufficient safeguards into the production system to prevent the occurrence of significant safety or environmental incidents. The DWOP, in conjunction with other permit applications, provides MMS the opportunity to assure that the production system is suitable for the conditions in which it will operate.

The MMS recently completed a review of several industry-developed, recommended practices that address the mooring and risers for floating production facilities. The recommended practices address such things as riser design, mooring system design (stationkeeping), and hazard analysis. The MMS is in the process of incorporating these recommended practices into the existing regulations. Hazard analyses allow MMS to be assured that the operator has anticipated emergencies and is prepared to address such, either through their design or through the operation of the equipment in question.

Conservation Reviews

One of MMS's primary responsibilities is to ensure development of economically producible reservoirs according to sound conservation, engineering and economic practices as cited in 30 CFR 250.202 (c), 250.203, 250.204, 250.205, 250.210, 250.296, 250.297, 250.298, 250.299, and 250.1101. Operators should submit the necessary information as part of their EP, initial and supplemental DOCD, and Conservation Information Document (CID). Conservation reviews are performed to ensure that economic reserves are fully developed and produced, and that there is no harm to the ultimate recovery.

Development Operations and Coordination Documents

Before any development operations can begin on a lease in the proposed lease sale area, a DOCD must be submitted to MMS for review and decision. A DOCD describes the proposed development activities, drilling activities, platforms or other facilities, proposed production operations, environmental monitoring plans, and other relevant information, and it includes a proposed schedule of development and production activities. Requirements for lessees and operators submitting a DOCD are addressed in 30 CFR 250.241-250.242, and information guidelines for DOCD's are given in NTL's 2006-G14 and 2006-G15.

After receiving a DOCD, MMS performs technical and environmental reviews. The MMS evaluates the proposed activity for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, State CZMA requirements, and other uses (e.g., military operations) of the OCS. The DOCD is reviewed for compliance with all applicable laws and regulations.

A CER, EA, and/or EIS are prepared in support of the NEPA environmental review of a DOCD. The CER, EA, and/or EIS is based on available information, which may include the geophysical report (for determining the potential for the presence of deepwater benthic communities); archaeological report; air emissions data; live-bottom survey and report; biological monitoring plan; and recommendations by the affected State(s), DOD, FWS (for selected plans under provisions of a DOI agreement), NOAA Fisheries Service, and/or internal MMS offices.

As part of the review process, the DOCD and supporting environmental information may be sent to the affected State(s) for consistency certification review and determination under the States' Federally-approved coastal program. The OCSLA (43 U.S.C. 1345(a) through (d) and 43 U.S.C. 1351(a)(3)) provides for this coordination and consultation with the affected State and local governments concerning a DOCD.

New or Unusual Technologies

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. The MMS prepared a programmatic EA to evaluate potential effects of deepwater technologies and operations (USDOI, MMS, 2000). As a supplement to the EA, MMS prepared a series of technical papers that provides a profile of the different types of development and production structures that may be employed in the GOM deep water (Regg et al., 2000). The EA and technical papers were used in the preparation of this EIS.

New or unusual technologies (NUT's) may be identified by the operator in its EP, DWOP, and DOCD or through MMS's plan review processes. Some of the technologies proposed for use by the operators are actually extended applications of existing technologies and interface with the environment in essentially the same way as well-known or conventional technologies. These technologies are reviewed by MMS for alternative compliance or departures that may trigger additional environmental review. Some examples of new technologies that do not affect the environment differently and that are being deployed in the OCS Program are synthetic mooring lines, subsurface safety devices, and multiplex subsea controls.

Some new technologies differ in how they function or interface with the environment. These include equipment or procedures that have not been installed or used in GOM OCS waters. Having no operational history, they have not been assessed by MMS through technical and environmental reviews. New technologies may be outside the framework established by MMS regulations and, thus, their performance (safety, environmental protection, efficiency, etc.) has not been addressed by MMS. The degree to which these new technologies interface with the environment and the potential impacts that may result are considered in determining the level of NEPA review that would be initiated.

The MMS has developed a NUT's matrix to help facilitate decisions on the appropriate level of engineering and environmental review needed for a proposed technology. Technologies will be added to the NUT's matrix as they emerge, and technologies will be removed as sufficient experience is gained in their implementation. From an environmental perspective, the matrix characterizes new technologies into three components: technologies that may affect the environment, technologies that do not interact with the environment any differently than "conventional" technologies, and technologies that MMS does not have sufficient information to determine its potential impacts to the environment. In this later case, MMS will seek to gain the necessary information from operators or manufacturers regarding the technologies to make an appropriate determination on its potential effects on the environment.

Alternative Compliance and Departures: The MMS's project-specific engineering safety review ensures that equipment proposed for use is designed to withstand the operational and environmental condition in which it would operate. When an OCS operator proposes the use of technology or procedures not specifically addressed in established MMS regulations, the operations are evaluated for alternative compliance or departure determination. Any new technologies or equipment that represent an alternative compliance or departure from existing MMS regulation must be fully described and justified before it would be approved for use. For MMS to grant alternative compliance or departure approval, the operator must demonstrate an equivalent or improved degree of protection as specified in 30 CFR 250.141. Comparative analysis with other approved systems, equipment, and procedures is one tool that MMS uses to assess the adequacy of protection provided by alternative technology or operations. Actual operational experience is necessary with alternative compliance measures before MMS would consider them as proven technology.

Emergency Plans

Criteria, models, and procedures for shutdown operations and the orderly evacuation for a pending hurricane have been in place in the GOM OCS for more than 30 years. Operating experience from extensive drilling activities and more than 4,000 platforms during the 30-plus years of the GOM OCS Program have demonstrated the effectiveness and safety of securing wells and evacuating a facility in advance of severe weather conditions. Preinstallation efforts, historical experience with similar systems, testing, and the actual operating experience (under normal conditions and in response to emergency situations) is to formulate the exact time needed to secure the wells/production facility and to abandon as necessary. Operators will develop site-specific curtailment/securing/evacuation plans that will vary in complexity and formality by operator and type of activity. In general terms, all plans are intended to make sure the facility (or well) is secured in advance of a pending storm or developing emergency. The operating procedures developed during the engineering, design, and manufacturing phases of the project, coupled with the results (recommended actions) from hazard analyses performed, will be used to develop the emergency action/curtailment plans. Evacuation and production curtailment must consider a combination of factors, including the well status (drilling, producing, etc.), and the type and mechanics of wellbore operations. These factors are analyzed onsite through a decision making process that involves onsite facility managers. The emphasis is on making real-time, situation-specific decisions and forecasting based on available information. Details of the shut-in criteria and various alerts are addressed on a case-by-case basis.

Plans for shutting in production from the subsea wells are addressed as part of the emergency curtailment plan. The plan specifies the various alerts and shutdown criteria linked to both weather and facility performance data, with the intent to have operations suspended and the wells secured in the event of a hurricane or emergency situation. Ensuring adequate time to safely and efficiently suspend operations and secure the well is a key component of the planning effort. Clearly defined responsibilities for the facility personnel are part of the successful implementation of the emergency response effort.

For a severe weather event such as a hurricane, emergency curtailment plans would address the criteria and structured procedures for suspending operations and ultimately securing the wellbore(s) prior to weather conditions that could exceed the design operating limitations of the drilling or production unit. For drilling operations, the plan might also address procedures for disconnecting and moving the drilling unit off location after the well has been secured, should the environmental conditions exceed the floating drilling unit's capability to maintain station. Curtailment of operations consists of various stages of "alerts" indicating the deterioration of meteorological, oceanographic, or wellbore conditions. Higher alert levels require increased monitoring, the curtailment of lengthy wellbore operations, and, if conditions warrant, the eventual securing of the well. If conditions improve, operations could resume based on the limitations established in the contingency plan for the known environmental conditions. The same emergency curtailment plans would be implemented in an anticipated or impending emergency situation, such as the threat of terrorist attack.

Neither MMS nor USCG mandates that an operator must evacuate a production facility for a hurricane; it is a decision that rests solely with the operator. The USCG does require the submittal of an emergency evacuation plan that addresses the operator's intentions for evacuation of nonessential personnel, egress routes on the production facility, lifesaving and personnel safety devices, firefighting equipment, etc. As activities move farther from shore, it may become safer to not evacuate the facility because helicopter operations become inherently more risky with greater flight times. Severe weather conditions also increase the risks associated with helicopter operations. The precedent for leaving a facility manned during severe weather is established in North Sea and other operating basins.

Redundant, fail-safe, automatic shut-in systems located inside the wellbore and at the sea surface, and in some instances at the seafloor, are designed to prevent or minimize pollution. These systems are designed and tested to ensure proper operation should a production facility or well be catastrophically damaged. Testing occurs at regular intervals with predetermined performance limits designed to ensure functioning of the systems in case of an emergency.

Permits and Applications

After EP or DOCD approval, the operator submits applications for specific activities to MMS for approval. These applications include those for drilling wells; well-test flaring; temporary well abandonment; installing a well protection structure, production platforms, satellite structures, subsea wellheads and manifolds, and pipelines; installation of production facilities; commencing production operations; platform removal and lease abandonment; and pipeline decommissioning.

Wells

The MMS requirements for the drilling of wells can be found at 30 CFR 250 Subpart D. Lessees are required to take precautions to keep all wells under control at all times. The lessee must use the best available and safest technology to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow.

Prior to conducting drilling operations, the operator is required to submit and obtain approval for an APD. The APD requires detailed information—including project layout at a scale of 24,000:1, design criteria for well control and casing, specifications for blowout preventers, a mud program, cementing program, directional drilling plans, etc.—to allow evaluation of operational safety and pollution-prevention measures. The APD is reviewed for conformance with the engineering requirements and other technical considerations.

The MMS is responsible for conducting technical and safety reviews of all drilling, workover, and production operations on the OCS. These detailed analyses determine if the lessee's proposed operation is in compliance with all regulations and all current health, safety, environmental, and classical engineering standards. Compliance includes requirements for state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil-spill contingency plans, pollution-control equipment, H_2S contingency plans, and specifications for platform/structure designs. These safety, technical, and engineering reviews involve risk assessment and a thorough analysis of the hazards involved. Safety systems used for drilling, workover, and production operations on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. Specific requirements for sundry notices for well workovers, completions, and abandonments are detailed in 30 CFR 250 Subparts F, E, and Q, respectively.

The MMS regulations at 30 CFR 250.1710-1717 address the requirements for permanent abandonment of a well on the OCS. A permanent abandonment includes the isolation of zones in the open wellbore, plugging of perforated intervals, plugging the annular space between casings (if they are open), setting a surface plug, and cutting and retrieving the casing at least 15 ft below the mudline. All plugs must be tested in accordance with the regulations. There are no routine surveys of permanently abandoned well locations. If a well were found to be leaking, MMS would require the operator of record to perform an intervention to repair the abandonment. If a well is temporarily abandoned at the seafloor, an operator must provide MMS with an annual report summarizing plans to permanently abandon the well or to bring the well into production. Part of the annual report for a temporarily abandoned well is a survey of the well location to ensure the temporary abandonment is intact and adequately restricting any reservoir fluids from migrating out of the well. All equipment such as wellheads, production trees, casing, manifolds, etc., must be designed to withstand the maximum pressures that they may experience. These designs are verified by MMS through multiple levels of engineering safety reviews prior to the equipment being placed into service.

Platforms and Structures

The MMS does a technical and safety review of all proposed structure designs and installation procedures. All proposed facilities are reviewed for structural integrity. These detailed classical engineering reviews entail an intense evaluation of all operator proposals for fabrication, installation, modification, and repair of all mobile and fixed structures. The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations. Applications for platform and structure approval are filed in accordance with 30 CFR 250.901. Design requirements are presented in detail at 30 CFR 250.904 through 250.909. The lessee evaluates characteristic environmental conditions associated with operational functions to be performed. Factors such as waves, wind, currents, tides, temperature, and the potential for marine growth on the structure are considered. In addition, pursuant to 30 CFR 250.902 and 250.903, a program has been established by MMS to assure that new structures meeting the conditions listed under 30 CFR 250.900(c) are designed, fabricated, and installed using standardized procedures to prevent structural failures. This program facilitates review of such structures and uses third-party expertise and technical input in the verification process through the use of a Certified Verification Agent. After installation, platforms and structures are required to be periodically inspected and maintained under 30 CFR 250.912.

Pipelines

Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies, including DOI, DOT, COE, the Federal Energy Regulatory Commission (FERC), and the USCG. Aside from pipeline regulations, these agencies have the responsibility of overseeing and regulating the following areas: the placement of structures on the OCS and pipelines in areas that affect navigation; the certification of proposed projects involving the transportation or sale of interstate natural gas, including OCS gas; and the right of eminent domain exercised by pipeline companies onshore. In addition, DOT is responsible for promulgating and enforcing safety regulations for the transportation in or affecting interstate commerce of natural gas, liquefied natural gas (LNG), and hazardous liquids by pipeline. This includes, for the most part, offshore pipelines on State lands beneath navigable waters and on the OCS that are operated by transmission companies. The regulations are contained in 49 CFR 191 through 193 and 195. In a MOU between DOT and DOI dated December 10, 1996, each party's respective regulatory responsibilities are outlined. The DOT is responsible for establishing and enforcing design, construction, operation, and maintenance regulations, and for investigating accidents for all OCS transportation pipelines beginning downstream of the point at which operating responsibility transfers from a producing operator to a transporting operator. The DOI's responsibility extends upstream from the transfer point described above.

The MMS is responsible for regulatory oversight of the design, installation, and maintenance of OCS producer-operated oil and gas pipelines. The MMS operating regulations for pipelines found at 30 CFR 250 Subpart J are intended to provide safe and pollution-free transportation of fluids in a manner that does not unduly interfere with other users of the OCS. Pipeline applications are usually submitted and reviewed separately from DOCD's. Pipeline applications may be for on-lease pipelines or right-of-way for pipelines that cross other lessees' leases or unleased areas of the OCS. Pipeline permit applications to MMS include the pipeline location drawing, profile drawing, safety schematic drawing, pipe design data, a shallow hazard survey report, and an archaeological report, if applicable.

The DOI has regulatory responsibility for all producer-operated pipelines. The DOI's responsibility extends downstream from the first production well to the last valve and associated safety equipment on the last OCS-related production system along the pipeline. The DOT's regulatory responsibility extends shoreward from the last valve on the last OCS-related production facility.

The MMS evaluates the design, fabrication, installation, and maintenance of all OCS pipelines. Proposed pipeline routes are evaluated for potential seafloor or subsea geologic hazards and other natural or manmade seafloor or subsurface features or conditions (including other pipelines) that could have an adverse impact on the pipeline or that could be adversely impacted by the proposed operations. Routes are also evaluated for potential impacts on archaeological resources and biological communities. A NEPA review is conducted in accordance with applicable policies and guidelines. The MMS prepares an EA on all pipeline rights-of-way that go ashore. For Federal consistency, applicants must comply with the requirements of NTL 2002-G15. All Gulf States require consistency review of ROW pipeline applications as described in the subject NTL.

The design of the proposed pipeline is evaluated for an appropriate cathodic protection system to protect the pipeline from leaks resulting from the effects of external corrosion of the pipe; an external pipeline coating system to prolong the service life of the pipeline; measures to protect the inside of the pipeline from the detrimental effects, if any, of the fluids being transported; the submersibility of the line (i.e., that the pipeline will remain in place on the seafloor and not have the potential to float, even if empty or filled with gas rather than liquids); proposed operating pressure of the line, and protection of other pipelines crossing the proposed route. Such an evaluation includes (1) reviewing the calculations used by the applicant in order to determine whether the applicant properly considered such elements as the grade of pipe to be used, the wall thickness of the pipe, derating factors related to the submerged and riser portions of the pipeline, the pressure rating of any valves or flanges to be installed in the pipeline, the pressure rating of any other pipeline(s) into which the proposed line might be tied, the required pressure to which the line must be tested before it is placed in service; (2) protective safety devices such as pressure sensors and remotely operated valves, the physical arrangement of those devices proposed to be installed by the applicant for the purposes of protecting the pipeline from possible overpressure conditions and for detecting and initiating a response to abnormally low-pressure conditions; and (3) the applicant's planned compliance with regulations requiring that pipelines installed in water depths less than 200 ft (61 m) be buried to a depth of at least 3 ft (1 m) (30 CFR 250.1003). In addition, pipelines crossing fairways require a COE permit and must be buried to a depth of at least 10 ft (3 m) and to 16 ft (5 m) if crossing an anchorage area.

Operators are required to periodically inspect pipeline routes. Monthly overflights are conducted to inspect pipeline routes for leakage.

Applications for pipeline decommissioning must also be submitted for MMS review and approval. Decommissioning applications are evaluated to ensure they will render the pipeline inert and/or to minimize the potential for the pipeline becoming a source of pollution by flushing and plugging the ends;

and to minimize the likelihood that the decommissioned line will become an obstruction to other users of the OCS by filling it with water and burying the ends.

Inspection and Enforcement

The OCSLA authorizes and requires MMS to provide for both an annual scheduled inspection and a periodic unscheduled (unannounced) inspection of all oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation.

The primary objective of an initial inspection is to assure proper installation of mobile drilling units and fixed structures, and proper functionality of their safety and pollution prevention equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain an MMS presence, and to focus on operators with a poor performance record. These inspections are also conducted after a critical safety feature has previously been found defective. Poor performance generally means that more frequent, unannounced inspections may be conducted on a violator's operation.

The annual inspection examines all safety equipment designed to prevent blowouts, fires, spills, or other major accidents. These annual inspections involve the inspection for installation and performance of all platform, safety-system components.

The inspectors follow the guidelines as established by the regulations, API RP 14C, and the specific MMS-approved plan. The MMS inspectors perform these inspections using a national checklist called the Potential Incident of Noncompliance (PINC) list. This list is a compilation of yes/no questions derived from all regulated safety and environmental requirements. Information PINC's can be found at http://www.mms.gov/regcompliance/inspect.htm.

The MMS administers an active civil penalties program (30 CFR 250, Subpart N). A civil penalty in the form of substantial monetary fines may be issued against any operator that commits a violation that may constitute a threat of serious, irreparable, or immediate harm or damage to life, property, or the environment. The MMS may make recommendations for criminal penalties if a willful violation occurs. In addition, the regulation at 30 CFR 250.173(a) authorizes suspension of any operation in the GOM Region if the lessee has failed to comply with a provision of any applicable law, regulation, or order or provision of a lease or permit. Furthermore, the Secretary may invoke his authority under 30 CFR 250.185(c) to cancel a nonproductive lease with no compensation. Exploration and development activities may be canceled under 30 CFR 250.182 and 250.183.

Pollution Prevention, Oil-Spill Response Plans, and Financial Responsibility

Pollution Prevention

Pollution prevention is addressed through proper design and requirements for safety devices. The MMS regulations at 30 CFR 250.400 require that the operator take all necessary precautions to keep its wells under control at all times. The lessee is required to use the best available and safest drilling technology in order to enhance the evaluation of conditions of abnormal pressure and to minimize the potential for the well to flow or kick. Redundancy is provided for critical safety devices that will shut off flow from the well if loss of control is encountered.

In addition, MMS regulations at 30 CFR 250.500, 250.600, and 250.800 require that the lessee assure the safety and protection of the human, marine, and coastal environments during completion, workover, and production operations. All production facilities, including separators, treaters, compressors, headers, and flowlines are required to be designed, installed, tested, maintained, and used in a manner that provides for efficiency, safety of operations, and protection of the environment. Wells, particularly subsea wells, include a number of sensors that help in detecting pressures and the potential for leaks in the production system. Safety devices are monitored and tested frequently to ensure their operation, should an incident occur. To ensure that safety devices are operating properly, MMS incorporates the American Petroleum Institute (API) Recommended Practice (RP) 14C into the operating regulations. API RP 14C incorporates the knowledge and experience of the oil and gas industry regarding the analysis, design, installation, and testing of the safety devices used to prevent pollution. API RP 14C presents proven practices for providing these safety devices for offshore production platforms. Proper application of these practices, along with good design, maintenance, and operation of the entire production facility, should provide an operationally safe and pollution-free production platform.

Also, MMS regulations at 30 CFR 250.1000 require that pipelines and associated valves, flanges, and fittings be designed, installed, operated, maintained, and abandoned to provide safe and pollution-free transportation of fluids in a manner that does not unduly interfere with other uses on the OCS.

The MMS regulation at 30 CFR 250.300(a) requires that lessees not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean during offshore oil and gas operations. The lessee is required to take measures to prevent the unauthorized discharge of pollutants into the offshore waters. Control and removal of pollution is the responsibility and at the expense of the lessee. Immediate corrective action to a pollution event is required. All hydrocarbon-handling equipment for testing and production, such as separators, tanks, and treaters, are required to be designed, installed, and operated to prevent pollution. Maintenance and repairs that are necessary to prevent pollution is required to be taken immediately. Drilling and production facilities are required to be inspected daily or at intervals approved or prescribed by the MMS District Supervisor to determine if pollution is occurring.

Operators are required to install curbs, gutters, drip pans, and drains on platform and rig deck areas in a manner necessary to collect all contaminants and debris not authorized for discharge. The rules also explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items must be marked in a durable manner with the owner's name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use. Operational discharges such as produced water and drilling muds and cuttings are regulated by the USEPA through the NPDES program. The MMS may restrict the rate of drilling fluid discharge or prescribe alternative discharge methods. No petroleum-based substances, including diesel fuel, may be added to the drilling mud system without prior approval of the MMS District Supervisor.

Oil-Spill Response Plans

The MMS's responsibilities under OPA 90 include spill prevention, review, and approval of oil-spill response plans (OSRP); inspection of oil-spill containment and cleanup equipment; and ensuring oil-spill financial responsibility for facilities in offshore waters located seaward of the coastline or in any portion of a bay that is connected to the sea either directly or through one or more other bays. The MMS regulations (30 CFR 254) require that all owners and operators of oil-handling, storage, or transportation facilities located seaward of the coastline submit an OSRP for approval. The term "coastline" means the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters. The term "facility" means any structure, group of structures, equipment, or device (other than a vessel), which is used for one or more of the following purposes: exploring for, drilling for, producing, storing, handling, transferring, processing, or transporting oil. A MODU is classified as a facility when engaged in drilling or downhole operations.

The regulation at 30 CFR 254.2 requires that an OSRP must be submitted and approved before an operator can use a facility. The MMS can grant an exception to this requirement during the MMS review of an operator's submitted OSRP. In order to be granted this exception during this time period, an owner/operator must certify in writing to MMS that it is capable of responding to a "worst-case" spill or the substantial threat of such a spill. To continue operations, the facility must be operated in compliance with the approved OSRP or the MMS-accepted "worst-case" spill certification. Owners or operators of offshore pipelines are required to submit an OSRP for any pipeline that carries oil, condensate, or gas with condensate; pipelines carrying essentially dry gas do not require an OSRP. Current OSRP's are required for abandoned facilities until they are physically removed or dismantled.

The OSRP describes how an operator intends to respond to an oil spill. The OSRP may be site-specific or regional (30 CFR 254.3). The term "regional" means a spill response plan that covers multiple facilities or leases of an owner or operator, including affiliates, which are located in the same MMS GOM Region. Although Regional OSRP's have not been allowed for facilities subject to the State of Florida consistency review in the past, MMS has recently initiated a new policy accepting subregional plans for this area. The subregional plan concept is similar to the regional concept, which allows leases or facilities to be grouped together for the purposes of (1) calculating response times, (2) determining quantities of response equipment, (3) conducting oil-spill trajectory analyses, (4) determining worst-case discharge scenarios, and (5) identifying areas of special economic and environmental importance that may be impacted and the strategies for their protection. The number and location of the leases and facilities allowed to be covered by a subregional OSRP will be decided by MMS on a case-by-case basis considering the proximity of the leases or facilities proposed to be covered. NTL 2006-G21 includes guidance on the preparation and submittal of subregional OSRP's.

The Emergency Response Action Plan within the OSRP serves as the core of the MMS required OSRP. In accordance with 30 CFR 254.23, the Emergency Response Action Plan requires identification of (1) the qualified individual and the spill-response management team, (2) the spill-response operating team, (3) the oil-spill response removal organizations under contract for response, and (4) the Federal, State, and local regulatory agencies that an owner/operator must notify or that they must consult with to obtain site-specific environmental information when an oil spill occurs. The OSRP is also required to include an inventory of appropriate equipment and materials, their availability, and the time needed for deployment, as well as information pertaining to dispersant use, *in situ* burning, a worse-case discharge scenario, contractual agreements, and training and drills. The response plan must provide for response to an oil spill from their facility and the operator must immediately carry out the provisions of the plan whenever an oil spill from the facility occurs. The OSRP must be in compliance with the National Contingency Plan and the Area Contingency Plan(s) (ACP). The operator is also required to carry out the training, equipment testing, and periodic drills described in the OSRP. All MMS-approved OSRP's must be reviewed at least every two years. In addition, revisions must be submitted to MMS within 15 days whenever:

(1) a change occurs that appreciably reduces an owner/operator's response capabilities;

(2) a substantial change occurs in the worst-case discharge scenario or in the type of oil being handled, stored, or transported at the facility;

(3) there is a change in the name(s) or capabilities of the oil-spill removal organizations cited in the OSRP; or

(4) there is a change in the applicable ACP's.

Financial Responsibility

The responsible party for COF's may have to demonstrate OSFR as required by regulation at 30 CFR 253. These regulations implement the OSFR requirements of Title I of OPA 90, as amended. Penalties for noncompliance with these requirements are covered at 30 CFR 250.51 and in NTL 99-N01, "Guidelines for Oil Spill Financial Responsibility for Covered Facilities." A COF, as defined in 30 CFR 253.3, is any structure and all of its components (including wells completed at the structure and the associated pipelines), equipment, pipeline, or device (other than a vessel or other than a pipeline or deepwater port licensed under the Deepwater Port Act of 1974) used for exploring, drilling, or producing oil, or for transporting oil from such facilities. The MMS ensures that each responsible party has sufficient funds for removal costs and damages resulting from the accidental release of liquid hydrocarbons into the environment for which the responsible party is liable.

Air Emissions

The OCSLA (43 U.S.C. 1334(a)(8)) requires the Secretary of the Interior to promulgate and administer regulations that comply with the National Ambient Air Quality Standards (NAAQS), pursuant to the CAA (42 U.S.C. 7401 *et seq.*), to the extent that authorized activities significantly affect the air quality of any State. Under provisions of the CAA Amendments (CAAA) of 1990, the USEPA Administrator has jurisdiction and, in consultation with the Secretary of the Interior and the Commandant of the Coast Guard, established the requirements to control air pollution in Outer Continental Shelf (OCS) areas of the Pacific, Atlantic, Arctic, and eastward of 87.5^{o} W. longitude in the GOM. Air Quality in the OCS area westward of 87.5^{o} W. longitude, in the Gulf, is under MMS jurisdiction.

For OCS air emission sources located east of 87.5° W. longitude and within 25 mi of the states seaward boundaries, the requirements are the same as would be applicable if the source were located in the corresponding onshore area. The USEPA requirements for these OCS areas are at 40 CFR 55, Appendix A. For air emission sources located east of 87.5° W. longitude and more than 25 mi from states seaward boundaries, sources are subject to Federal requirements for Prevention of Significant Deterioration (PSD). A portion of the proposed CPA sale area falls east of 87.5° W. longitude, where the CAA assigns air quality jurisdiction to USEPA. Operators with actions that affect air quality in this area must comply with USEPA air quality regulations and submit air permit applications to USEPA for approval. The USEPA regulations also establish procedures that allow the USEPA Administrator to exempt any OCS source from an emissions control requirement if it is technically infeasible or poses unreasonable threat to health or safety.

To comply with the CAAA, MMS adjusted regulations in 30 CFR 250 Subpart C to apply regulatory authority to only those OCS air emission sources west of 87.5° W. longitude. The regulated pollutants include: carbon monoxide, suspended particulates, sulphur dioxide, nitrogen oxides, total hydrocarbons, and volatile organic compounds. All new or supplemental Exploration Plans and Development Operations Coordination Documents must include air emissions information sufficient to perform an air quality review. The MMS regulations require a review of air quality emissions to determine if the projected emissions from a facility result in onshore ambient air concentrations above MMS significance levels, and to identify appropriate emissions controls to mitigate potential onshore air quality degradation.

Emissions data for new or modified onshore facilities directly associated with proposed OCS activities are required to be included in development plans submitted to MMS so that affected States can determine potential air quality impacts on its air quality.

The MMS uses a two-level hierarchy of evaluation criteria to evaluate potential impacts of offshore emission sources to onshore areas. The evaluation criteria are the exemption level and the significance level. If the proposed activities exceed the criteria at the first (exemption) level, the evaluation moves to the significance level criteria. The initial evaluation compares the worst-case emissions to the MMS exemption criteria. This corresponds to the USEPA screening step, where the proposed activity emissions are checked against the screening thresholds or "exemption levels." If the proposed activity emissions are below the exemption levels, the proposed actions are exempt from further air quality review.

If exemption levels are exceeded, then the second step requires refined modeling using the OCD model. The results from the OCD model, the modeled potential onshore impacts, are compared to MMS significance levels. If the significance levels are exceeded in an attainment area, an area that meets the national ambient air quality standards, the operator would be required to apply best available control technology to the emissions source. If the affected area is classified non-attainment, further emission reductions or offsets may be required. Projected contributions to onshore pollutant concentrations are also subject to the same limits as the USEPA applies to the onshore areas under their PSD program.

Flaring/Venting

Flaring is the controlled burning of natural gas and venting is releasing gas directly into the atmosphere without burning. Flaring/venting may be necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate reservoir development options, during unloading/testing operations, and/or in emergency situations. The MMS regulates flaring/venting to minimize the loss of, revenue producing, natural gas resources. The MMS regulations (30 CFR 250) allow, without prior MMS approval, flaring or venting of natural gas, on a limited basis under certain specified conditions. Regulations permit more extensive flaring/venting with prior approval from MMS. Records must always be prepared by the operator for all flaring/venting and justification must be provided for flaring/venting not expressly authorized by MMS regulations.

Hydrogen Sulfide Contingency Plans

The operator of a lease must request an MMS area classification for the presence of hydrogen sulfide (H_2S) gas. The MMS classifies areas for proposed operations as (1) H_2S absent, (2) H_2S present, or (3) H_2S unknown.

All OCS operators concerned with the production of sour (contains H_2S) hydrocarbons that could result in atmospheric H_2S concentrations above 20 parts per million are required to file an H_2S contingency plan with MMS. This plan must include the 30 CFR 250 requirements, intended to ensure workers safety at the production facility and contingencies for; simultaneous drilling, well-completion, well-workovers, and production operations. NTL 98-16, "Hydrogen Sulfide (H_2S) Requirements," provides clarification, guidance, and information regarding MMS's H_2S regulations at 30 CFR 250.

Archaeological Resources Regulation

The archaeological resources regulation at 30 CFR 250.194 grants specific authority to each MMS Regional Director to require archaeological resource surveys and reports where deemed necessary. The technical requirements of the archaeological resource surveys and reports are detailed in NTL 2005-G07. Specific lease blocks that require an archaeological survey and assessment are identified in NTL 2006-G07. Both of these NTL's are issued by the MMS's GOM OCS Region. The regulations at 30 CFR 250.227(b)(6) and 30 CFR 250.261(b)(6) require the lessee to include an archaeological report with an EP or DOCD. If the evidence suggests that an archaeological resource may be present, the lessee must either locate the site of any operation so as not to adversely affect the area where the archaeological resource may be, demonstrate that an archaeological resource does not exist, or demonstrate that archaeological resources will not be adversely affected by operations. If the lessee discovers any archaeological resource while conducting approved operations, operations must be immediately stopped and the discovery reported to the MMS Regional Supervisor, Office of Leasing and Environment, within 48 hours of its discovery.

Coastal Zone Management Consistency Review and Appeals for Plans

The Coastal Zone Management Act (CZMA) places requirements on any applicant for an OCS plan that describes in detail Federal license or permit activities affecting any coastal use or resource, in or outside of a State's coastal zone. The applicant must provide in the OCS plan submitted to MMS a certification and necessary data and information for the State to determine that the proposed activities comply with the enforceable policies of the States' approved program, and that such activities will be conducted in a manner consistent with the program (16 U.S.C. 1456(c)(3)(A) and 15 CFR 930.76.).

Except as provided in 15 CFR 930.60(a), State agency review of the consistency information begins when the State receives the OCS plan, consistency certification, and required necessary data and information. Only missing information can be used to delay the commencement of State agency review, and a request for information and data in addition to that required by 15 CFR 930.76 will not extend the date of commencement of review (15 CFR 930.58). The information requirements for CZM purposes are found at 30 CFR 250.226 and 250.260 and are discussed in NTL's 2006-G14 and 2006-G15. Under the CZMA, each State with an approved CZM plan may require information that is different than that specifically outlined in these regulations. All of the Gulf States have approved CZM programs. Requirements for the CZM consistency information for Texas, Louisiana, Mississippi, Alabama, and Florida are given in NTL's 2006-G14 and 2006-G15. In accordance with the requirements of 15 CFR 930.76, the MMS, GOM OCS Region sends copies of an OCS plan, including the consistency certification and other necessary information, to the designated State CZM agency by receipted mail or other approved communication. If no State-agency objection is submitted by the end of the consistency review period, MMS shall presume consistency concurrence by the State (15 CFR 930.78 (b)). The MMS can require modification of a plan if the operator has agreed to certain requirements requested by the State.

If the MMS receives a written consistency objection from the State, the MMS will not approve any activity described in the OCS plan unless (1) the operator amends the OCS plan to accommodate the objection, concurrence is subsequently received or conclusively presumed; (2) upon appeal, the Secretary of Commerce, in accordance with 15 CFR 930 Subpart H, finds that the OCS plan is consistent with the objectives or purposes of the CZMA or is necessary in the interest of national security; or (3) the original objection is declared invalid by the courts.

Best Available and Safest Technologies

To assure that oil and gas exploration, development, and production activities on the OCS are conducted in a safe and pollution-free manner, 43 U.S.C. 1347(b) of the OCSLA, as amended, requires that all OCS technologies and operations use the best available and safest technology (BAST) whenever practical. The Director may require additional BAST measures to protect safety, health, and the environment, if it is economically feasible and the benefits outweigh the costs. Conformance to the standards, codes, and practices referenced in 30 CFR 250 is considered the application of BAST. These standards, codes, and practices include requirements for state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil-spill response plans, pollution-control equipment, and specifications for platform/structure designs. The MMS conducts periodic offshore inspections, and continuously and systematically reviews OCS technologies to ensure that the best available and safest technologies are applied to OCS operations. The BAST is not required when MMS determines that the incremental benefits are clearly insufficient to justify increased costs; however, it is the responsibility of an operator of an existing operation to demonstrate why application of a new technology would not be feasible. This requirement is applicable to equipment and procedures that, if failed, would have a significant effect on safety, health, or the environment, unless benefits clearly do not justify the cost (30 CFR 250.107(c) and (d)).

The BAST concept is addressed in the MMS, GOM OCS Region by a continuous effort to locate and evaluate the latest technologies and to report on these advances at periodic Regional Operations Technology Assessment Committee (ROTAC) meetings. A part of the MMS staff has an ongoing function to evaluate various vendors and industry representatives' innovations and improvements in techniques, tools, equipment, procedures, and technologies applicable to oil and gas operations (drilling, producing, completion, and workover operations). This information is provided to MMS district personnel at ROTAC meetings. The requirement for the use of BAST has been, for the most part, an evolutionary process whereby advances in equipment, technologies, and procedures have been integrated into OCS operations over a period of time. Awareness by both MMS inspectors and the OCS operators of the most advanced equipment and technologies has resulted in the incorporation of these advances into day-to-day operations. An example of such an equipment change that evolved over a period of time would be the upgrading of diverter systems on drilling rigs from the smaller diameter systems of the past to the large-diameter, high-capacity systems found on drilling rigs operating on the OCS today. Another example of a BAST-required equipment change would be the requirement to replace subsurface-controlled, subsurface safety valves with surface-controlled, subsurface safety-valve systems, which incorporate a more positive closure design and operation.

Production Facilities

The MMS's regulations governing oil and gas production safety systems are found in 30 CFR 250 Subpart H. Production safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. All tubing installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that will shut off the flow from the well in the event of an emergency, unless the well is incapable of flowing. Surface- and subsurface-controlled safety valves and locks must conform to the requirements of 30 CFR 250.801. All surface production facilities, including separators, treaters, compressors, headers, and flowlines must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment. Production facilities also have stringent requirements concerning electrical systems, flowlines, engines, and firefighting systems. The safety-system devices are tested by the lessee at specified intervals and must be in accordance with API RP 14 C Appendix D and other measures.

Personnel Training and Education

An important factor in ensuring that offshore oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage is the proper training of personnel. Under 30 CFR 250.1500 Subpart O, MMS has outlined well control and production safety training program requirements for lessees operating on the OCS. The goal of the regulation (30 CFR

250.1501) is safe and clean OCS operations. Lessees must ensure that their employees and contract personnel engaged in well control or production safety operations understand and can properly perform their duties. To accomplish this, the lessee must establish and implement a training program so that all of their employees are trained to competently perform their assigned well control and production safety duties. The lessee must also verify that their employees understand and can perform the assigned duties.

The mandatory Drilling Well-Control Training Program was instituted by MMS in 1979. In 1983, the mandatory Safety Device Training Program was established to ensure that personnel involved in installing, inspecting, testing, and maintaining safety devices are qualified. As a preventive measure, all offshore personnel must be trained to operate oil-spill cleanup equipment, or the lessee must retain a trained contractor(s) to operate the equipment for them. In addition, MMS offers numerous technical seminars to ensure that personnel are capable of performing their duties and are incorporating the most up-to-date safety procedures and technology in the petroleum industry. In 1994, the Office of Safety Management (OSM) created the MMS Offshore Training Institute to develop and implement an inspector training program. The Institute introduced state-of-the-art multimedia training to the inspector work force and has produced a series of interactive computer training modules.

Structure Removal and Site Clearance

During exploration, development, and production operations, temporary and permanent equipment and structures is often required to be embedded into or placed onto the seafloor around activity areas. In compliance with Section 22 of MMS's Oil and Gas Lease Form (MMS-2005) and OCSLA regulations (30 CFR 250.1710—*Wellheads/Casings* and 30 CFR 250.1725—*Platforms and Other Facilities*), operators need to remove seafloor obstructions from their leases within one year of lease termination or after a structure has been deemed obsolete or unusable. These regulations also require the operator to sever bottom-founded objects and their related components at least 5 m (15 ft) below the mudline (30 CFR 250.1716(a)—*Wellheads/Casings* and 30 CFR 250.1728(a)—*Platforms and Other Facilities*). The severance operations are generally categorized as explosive or nonexplosive.

In 1988, MMS requested a "generic" consultation from NOAA Fisheries Service pursuant to Section 7 of the ESA concerning potential impacts on endangered and threatened species associated with explosive severance activities conducted during the structure-removal operations. The consultation's BiO concentrated primarily on structure removals in water depths <200 m (656 ft); therefore, the Incidental Take Statement (ITS) was limited to the five species of sea turtle found on the shallow shelf. Reporting guidelines and specific mitigation measures are outlined in the ITS and include (1) the use of a qualified NOAA Fisheries Service observer, (2) aerial surveys, (3) detonation delay radii, (4) nighttime blast restrictions, (5) charge staggering and grouping, and (6) possible diver survey requirements.

In 1989, the American Petroleum Institute (API) petitioned NOAA Fisheries Service under the MMPA regulations for the incidental take of spotted and bottlenose dolphins during structure-removal operations. The Incidental Take Authorization regulations were promulgated by NOAA Fisheries Service in October 1995 (60 FR 53139, October 12, 1995), and on April 10, 1996 (61 FR 15884), the regulations were moved to Subpart M (50 CFR 216.141 *et seq*.) of the MMPA regulations. Effective for 5 years, the regulations detailed conditions, reporting requirements, and mitigative measures similar to those listed in the 1988 ESA Consultation requirements for sea turtles. After the regulations expired in November 2000, NOAA Fisheries Service and MMS advised operators to continue following the guidelines and mitigative measures of the lapsed subpart pending a new petition and subsequent regulations. At industry's prompting, NOAA Fisheries Service released interim regulations in August 2002, which expired on February 2, 2004. Operators continue to follow the interim conditions until NOAA Fisheries Service promulgates new regulations.

Emphasizing a continued need for an incentive to keep explosive weights low, MMS formally requested that NOAA Fisheries Service amend the 1988 BiO to establish a minimum charge size of 5 lb. The NOAA Fisheries Service subsequently addressed explosive charges ≤5 lb in a separate, informal BiO. The October 2003 "de minimus" BiO waives several mitigative measures of the 1988 BiO (i.e., aerial observations, 48-hr pre-detonation observer coverage, on-site NOAA personnel, etc.), reduces the potential impact zone from 3,000 ft to 700 ft, and gives the operators/severing contractors the opportunity to conduct their own observation work. All of the current terms and conditions of structure and well removal activities are covered in NTL 2004-G06, "Structure Removal Operations."

The MMS has recently prepared a programmatic EA (PEA) (USDOI, MMS, 2005a) that assesses the potential impacts of all decommissioning activities and related salvage operations on the GOM. The PEA and its associated FONSI were published in March 2005. Topics of primary concern addressed in the PEA include pre-severance operations, severance technologies, industry needs related to water depth and location, and the potential impacts of decommissioning operations on the marine environment. Information from the PEA was used to prepare a new petition for rulemaking by the NOAA Fisheries Service for incidental take regulations under Subpart I of the MMPA. The MMS has also requested initiation of a new formal consultation for explosive severance activities under Section 7 of the ESA using information from the PEA. Work is currently proceeding on both the MMPA and ESA efforts, and MMS expects to have new take regulations and the consultation finalized by the end of 2006.

Once the all bottom-founded components are severed and the structures/wells are removed, operators must verify that the seafloor is clear of obstructions and the site is returned to prelease conditions. NTL 98-26, dated November 30, 1998, establishes site clearance verification procedures that include sonar surveys and/or trawling the cleared site by a licensed “shrimp” trawler to ensure that no “hangs” exist. The MMS requires operators to submit a procedural plan for site clearance verification, and once the sonar or trawling activities are completed, they are required to file reports on the results of their site clearance activities.

Marine Protected Species NTL’s

The Lease Sale 181 Marine Protected Species Stipulations are now embodied in NTL 2003-G10, “Vessel Strike Avoidance and Injured/Dead Protected Species Reporting,” and NTL 2003-G11, “Marine Trash and Debris Awareness and Elimination.” The requirements of these NTL’s apply to all existing and future oil and gas operations in the GOM OCS.

The NTL 2003-G10, “Vessel Strike Avoidance and Injured/Dead Protected Species Reporting,” explains how operators must implement measures to minimize the risk of vessel strikes to protected species and report observations of injured or dead protected species. Vessel operators and crews must maintain a vigilant watch for marine protected species and slow down or stop their vessel to avoid striking protected species. Crews must report sightings of any injured or dead protected species (marine mammals and sea turtles) immediately, regardless of whether the injury or death is caused by their vessel, to the Marine Mammal and Sea Turtle Stranding Hotline or the Marine Mammal Stranding Network. In addition, if it was their own vessel that collided with a protected species, MMS must be notified within 24 hours of the strike.

The NTL 2003-G11, “Marine Trash and Debris Awareness and Elimination,” provides guidance to prevent intentional and/or accidental introduction of debris into the marine environment. Operators are prohibited from deliberately discharging containers and other similar materials (i.e., trash and debris) into the marine environment (30 CFR 250.300(a) and (b)(6)) and are required to make durable identification markings on equipment, tools, containers (especially drums), and other material (30 CFR 250.300(c)). The intentional jettisoning of trash has been the subject of strict laws such as MARPOL-Annex V and the Marine Plastic Pollution Research and Control Act, and regulations imposed by various agencies including USCG and USEPA. These USCG and USEPA regulations require that operators become more proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. The NTL 2003-G11 states marine debris placards must be posted in prominent places on all fixed and floating production facilities that have sleeping or food preparation capabilities and on mobile drilling units. Operators must also ensure that all of their offshore employees and those contractors actively engaged in their offshore operations complete annual training that includes (1) viewing a training video or slide show (specific options are given in the NTL) and (2) receiving an explanation from the lessee company’s management that emphasizes their commitment to the message of this NTL. An annual report that describes the marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year is to be provided to MMS by January 31 of each year.

Rigs-to-Reefs

Rigs-to-Reefs (RTR) is a term for converting obsolete, nonproductive offshore oil and gas platforms to designated artificial reefs (Dauterive, 2000). Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry but can be a loss of productive marine habitat. The use of obsolete oil and gas platforms for reefs has proven to be highly successful. Their availability, design profile, durability, and stability provide a number of advantages over the use of traditional artificial reef materials. To capture this valuable fish habitat, the States of Louisiana, Texas, and Mississippi in 1986, 1989, and 1999, respectively, passed enabling legislation and signed into law RTR plans for their respective States. Alabama and Florida have no RTR legislation. The State laws set up a mechanism to transfer ownership and liability of the platform from oil and gas companies to the State when the platform ceases production and the lease is terminated. The company (donor) saves money by donating a platform to the State (recipient) for a reef rather than scrapping the platform onshore. The industry then donates 50 percent of the savings to the State to run the State's artificial reef program. Since the inception of the RTR plans, more than 240 retired platforms have been donated and used for reefs in the GOM.

1.6. OTHER OCS-RELATED ACTIVITIES

The MMS has programs and activities that are OCS related but not specific to the oil and gas leasing process or to the management of exploration, development, and production activities. These programs include both environmental and technical studies, and cooperative agreements with other Federal and State agencies for NEPA work, joint jurisdiction over cooperative efforts, inspection actives, and regulatory enforcement. The MMS also participates in industry research efforts and forums.

Environmental Studies Program

The ESP was established in 1973 in accordance with Section 20 of the OCSLA. The goals of the ESP are to obtain environmental and socioeconomic information that can be used to assess the potential and real effects of the GOM OCS natural gas and oil program. As a part of the ESP, the GOM OCS Region has funded more than 350 completed or ongoing environmental studies. The types of studies funded include

- literature reviews and baseline studies of the physical, chemical, and biological environment of the shelf;
- literature review and studies of the physical, chemical, and biological environment of deep water (>300 m or 1,000 ft);
- studies of the socioeconomic impacts along the Gulf Coast; and
- studies of the effects of oil and gas activities on the marine environment.

A list of the MMS's GOM OCS Region's studies completed from 2003 to August 2006 is presented in Appendix C. Studies completed since 1992 are available on the MMS Internet website at http://www.gomr.mms.gov/homepg/regulate/environ/techsumm/rec_pubs.html. The MMS's Environmental Studies Program Information System (ESPIS) provides immediate access to all completed MMS ESP studies (http://mmspub.mms.gov:81/search.html). The ESPIS is a searchable, web-based, full-text retrieval system allowing users to view on line or to download the complete text of any completed MMS ESP report. A complete description of all ongoing GOM OCS Region studies is available at http://www.gomr.mms.gov/homepg/regulate/environ/ ongoing_studies/gom.html. Each listing not only describes the research being conducted but also shows the institution performing the work, the cost of the effort, timeframe, and any associated publications, presentations, or affiliated web sites.

The ESP funds studies to obtain information needed for NEPA assessment and the management of environmental and socioeconomic impacts on the human, marine, and coastal environments that may be affected by OCS oil and gas development. The ESP studies were used by MMS's GOM OCS Region analysts to prepare this document. While not all of the MMS's GOM OCS Region studies are specifically referenced in this document, they were used by analysts as input into their analysis. The information in ESP studies is also used by decisionmakers to manage and regulate exploration, development, and production activities on the OCS.

Technical Assessment & Research Program

The Technical Assessment & Research (TA&R) Program supports research associated with operational safety and pollution prevention as well as oil-spill response and cleanup capabilities. The TA&R Program is comprised of two functional research activities: (1) operational safety and engineering research (topics such as air quality, decommissioning, and mooring and anchoring); and (2) oil-spill research (topics such as behavior of oil, chemical treating agents, and *in situ* burning of oil). The TA&R Program has four primary objectives.

- Technical Support—Providing engineering support in evaluating industry operational proposals and related technical issues and in ensuring that these proposals comply with applicable regulations, rules, and operational guidelines and standards.
- Technology Assessment—Investigating and assessing industry applications of technological innovations and ensuring that governing MMS regulations, rules, and operational guidelines ensure the use of BAST (**Chapter 1.5**).
- Research Catalyst—Promoting and participating in industry research initiatives in the fields of operational safety, engineering research, and oil-spill response and cleanup research.
- International Regulations—Supporting international cooperative efforts for research and development initiatives to enhance the safety of offshore oil and natural gas activities and the development of appropriate regulatory program elements worldwide.

Interagency Agreements

Memorandum of Understanding under NEPA

Section 1500.5(b) of the CEQ implementing regulations (40 CFR 1500.5(b)) encourages agency cooperation early in the NEPA process. A Federal agency can be a lead, joint lead, or cooperating agency. A lead agency manages the NEPA process and is responsible for the preparation of an EIS; a joint lead Agency shares these responsibilities; and a cooperating agency that has jurisdiction by law and has special expertise with respect to any environmental issue shall participate in the NEPA process upon the request of the lead agency.

When an agency becomes a Cooperating Agency, the cooperating and lead agencies usually enter into a Memorandum of Understanding (MOU), previously called a Cooperating Agency Agreement. The Agreement details the responsibilities of each participating agency. The MMS, as lead agency, has requested other Federal agencies to become cooperating agencies while other agencies have requested MMS to become a cooperating agency (e.g., the Ocean Express Pipeline project). Some projects, such as major gas pipelines across Federal waters and projects under the Deepwater Port Act of 1974, can require cooperative efforts by multiple Federal and State agencies.

The MMS entered into a Cooperating Agency Agreement with NOAA Fisheries Service in March 2004. The MMS has authority to review and approve applications for structure-removal operations in the GOM OCS. The NOAA Fisheries Service has authority under the MMPA as it pertains to granting permission, upon request, for the unintentional taking of small numbers of marine mammals incidental to activities related to offshore oil and gas exploration and development activities. The Cooperating Agency Agreement describes the agreed upon duties and responsibilities of the lead and participating agencies. The MMS is the lead agency for the preparation of the PEA, is a designated primary point of contact, and is the lead in setting up and holding any public meetings. The MMS will prepare all sections of the PEA, will provide draft copies of the PEA to NOAA Fisheries Service and will consider all comments, and will provide NOAA Fisheries Service with copies of all Draft PEA comments.

The NOI included an invitation to other Federal agencies and State, tribal, and local governments to consider becoming cooperating agencies in the preparation of this EIS. On March 23, 2006, MMS received a request from USEPA to be a cooperating agency. **Chapter 5.3.4** includes a discussion of the MOU between MMS and USEPA.

Memorandum of Understanding and Memoranda of Agreements Between MMS and Coast Guard

Since the MMS and USCG have closely related jurisdiction over different aspects of safety and operations on the OCS, the agencies have established a formal MOU that delineates lead responsibilities for managing OCS activities in accordance with OCSLA, as amended, and OPA 90. The latest MOU, dated September 30, 2004, supersedes the August 1989 and December 1998 versions of the interagency agreement. The MOU is designed to minimize duplication and promote consistent regulation of facilities under the jurisdiction of both agencies. A Memorandum of Agreement (MOA) OCS No.1 – Agency Responsibilities, between MMS and USCG, dated September 30, 2004, further clarifies the technical and process section of the MMS/USCG MOU. The MOA requires the participating agencies to review their internal procedures and, where appropriate, revise them to accommodate the provisions of the September 2004 MOA. To facilitate coordination with USCG, MMS has established a full-time position within the Office of Offshore Regulatory Programs to provide liaison between the agencies.

Generally, the MOU identifies MMS as the lead agency for matters concerning the equipment and operations directly involved in the production of oil and gas. These include, among others, design and operation of risers, permanent mooring foundations of the facility, drilling and well production and services, inspection and testing of all drilling-related equipment, and platform decommissioning. Issues regarding certain aspects of safe operation of the facility, its systems, and equipment generally fall under the jurisdiction of the USCG. These include, among others, design of vessels, their seakeeping characteristics, propulsion and dynamic positioning systems, supply and lightering procedures and equipment, utility systems, safety equipment and procedures, and pollution prevention and response procedures. In 2002, MMS was authorized to inspect USCG-related safety items on fixed facilities on the OCS.

Generally, the MOA identifies agency responsibilities (i.e., agency representatives for the purpose of keeping each other informed of issues, relevant applications, routine policy determinations and to coordinate joint activities), civil penalties (i.e., USCG refers civil penalty cases to the MMS), oil-spill financial responsibility (OSFR) (i.e., MMS determines and provides OSFR-related information to the USCG upon request), oil-spill preparedness and response planning (i.e., MMS requires responsible parties to maintain approved oil-spill-response plans consistent with Area Contingency Plans and the National Contingency Plan; personnel receive training and response equipment is inspected; jointly approve floating oil storage facilities; and advise MMS of spill-response activities), oil-spill response (i.e., reporting all spills to the National Response Center and direct measures to abate sources of pollution from an OCS facility), accident investigations (i.e., MMS and USCG responsible for investigating and preparing report of fires, spillage, injury, fatality and blowouts and collisions and allisions), and offshore facility system/subsystem responsibility matrix (identifies lead agency responsible for MODU, fixed, and floating systems and subsystem and coordinates with other agencies as appropriate).

On April 18, 2005, MMS and USCG met to identify MOA's that needed to be developed and to prioritize work. The following subject areas were selected: (a) civil penalties; (b) incident investigations; (c) offshore security; (d) oil-spill planning, preparedness, and response; (e) deepwater ports; (f) digital databases; 9g) mobile offshore drilling units (MODU's); (h) fixed platforms; (i) floating platforms; (j) floating, production, storage, and offloading units (FPSO's); and (k) incident reporting. Joint agency teams have been established to develop the MOA's for the first five subject areas. In addition, an MOA is also being pursued to address renewable energy and alternate use of the OCS. The Civil Penalties MOA was approved on September 12, 2006. The Oil-Spill Planning MOA has been drafted and is under legal counsel review with USCG and DOI. The Incident Investigation MOA has undergone regional review and is proceeding toward finalization.

Deepwater Port Agreement

The MMS is among several other Federal agencies that are a part of a MOU for licensing deepwater ports. The MOU emphasizes the importance of the lead agencies, USCG and the Maritime Administration, to receive specific information from subject matter experts in other participating agencies. The MOU establishes that agencies will work together with applicants and stakeholders, identify and resolve issues, attempt to build consensus among governmental agencies, and expedite environmental reviews required for licensing associated with deepwater ports. The MMS is responsible for issuing and enforcing regulations to promote safe operations and activities on the OCS, including leasing and minerals royalty programs, overseeing facility permitting, conducting NEPA analyses, granting pipeline rights-of-way, performing facility and operations inspection, and engaging appropriate engineering and oil-spill research. Other participating agencies include the NOAA Fisheries Service, NOS, COE, Office of Fossil Energy (DOE), FWS, Department of State (DOS), U.S. Department of Transportation Maritime Administration (MARAD), USEPA, FERC, and the Council on Environmental Quality (CEQ). The MMS has a Cooperating Agency Agreement with the USCG regarding deepwater ports and NEPA. Under the OCSLA, MMS has the authority to manage the exploration, development, and production of mineral resources located in the OCS. The MMS will designate a primary point of contact, provide a listing of subject matter experts available to assist in NEPA activities, participate in pre-application meetings, perform completeness and adequacy reviews, participate in scoping meetings, provide written comments and recommendations of all draft and interim final versions of NEPA documents prepared by USCG or its contractors, assist in the development of information and preparation of environmental analyses, and recommend mitigations to avoid or reduce impacts to environmental resources.

Marine Minerals Branch

The Marine Minerals Branch (MMB) manages the MMS's nonenergy minerals program in the GOM. Nonenergy minerals include sand, shell, and gravel. The MMB develops and procures contracts to assist in the acquisition of environmental data and information that would facilitate a NEPA analysis or add to the general knowledge base. The MMB offers and can enter into a noncompetitive lease (P.L. 103-426) for sand, shell, or gravel resources for certain types of projects funded in whole or part by or authorized by the Federal Government. The Shore Protection Provisions of the Water Resource Development Act of 1999 amended P.L. 103-426 by prohibiting charging State and local governments a fee for using OCS sand. For all other uses, a competitive bidding process is required under Section 8(k)(1) of the OCSLA. The MMS's nonenergy minerals program in the GOM is described in **Chapter 4.1.3.2.2**.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

2. ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

2.1. MULTISALE NEPA ANALYSIS

As authorized under 40 CFR 1502.4, one environmental impact statement (EIS) is allowed to analyze related or similar proposals. This EIS addresses five areawide oil and gas lease sales in the Western Planning Area (WPA) and six areawide oil and gas lease sales in the Central Planning Area (CPA) of the GOM OCS (**Figure 1-1**), as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (5-Year Program).

For analysis purposes, a proposed action is presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors for the WPA and CPA sale areas. Each of the proposed lease sales in a sale area is expected to be within the scenario ranges for the sale area; therefore, a WPA proposed action is representative of proposed WPA Lease Sales 204, 207, 210, 215, and 218, and a CPA proposed action is representative of proposed CPA Lease Sales 205, 206, 208, 213, 216, and 222. Each proposed action includes existing regulations and lease stipulations.

The multisale EIS approach is intended to focus the National Environmental Policy Act (NEPA)/EIS process on the differences between the proposed lease sales and new issues and information. It also lessens duplication and saves resources. The scoping process for this document is described in **Chapters 1.4 and 5.3.** As mandated by NEPA, this EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments.

This EIS will be the final NEPA review conducted for WPA Sale 204 and CPA Sale 205. An additional NEPA review (an environmental assessment (EA)) will be conducted prior to the each of the nine remaining proposed lease sales to address any relevant new information. Informal and formal consultations with other Federal agencies, the affected States, and the public will be carried out to assist in the determination of whether or not the information and analyses in this EIS are still valid. Specifically, Information Requests will be issued soliciting input on subsequent proposed lease sales.

Any subsequent EA's will tier from this EIS and will summarize and incorporate the material by reference. Because any subsequent EA's will be prepared for a proposal that "is, or is closely similar to, one which normally requires the preparation of an EIS" (40 CFR 1501.4(e)(2)), the EA will be made available for public review for a minimum of 30 days prior to making a decision on the proposed lease sale. Consideration of the EA and any comments received in response to the Information Request will result in either a Finding of No New Significant Impacts (FONNSI) or the determination that the preparation of a supplemental EIS (SEIS) is warranted. If the EA results in a FONNSI, the EA and FONNSI will be sent to the Governors of the affected States. The availability of the EA and FONNSI will be announced in the *Federal Register*. The FONNSI will become part of the documentation prepared for the decision on the Notice of Sale.

In some cases, the EA may result in a finding that it is necessary to prepare an SEIS (40 CFR 1502.9). Some of the factors that could justify a SEIS are a significant change in resource estimates, significant new information, significant new environmental issue(s), new proposed alternative(s), a significant change in the proposed action, or the analysis in this EIS is no longer deemed adequate.

If an SEIS is necessary, it will also tier from this EIS and will summarize and incorporate the material by reference. The analysis will focus on addressing the new issue(s) or concern(s) that prompted the decision to prepare the SEIS. The SEIS will include a discussion explaining the purpose of the SEIS, a description of the proposed action and alternatives, a comparison of the alternatives, a description of the affected environment for any potentially affected resources that are the focus of the SEIS and were not described in this EIS, an analysis of new impacts or changes in impacts from this EIS because of new information or the new issue(s) analyzed in the SEIS, and a discussion of the consultation and coordination carried out for the new issues or information analyzed in the SEIS.

2.2. ALTERNATIVES, MITIGATING MEASURES, AND ISSUES

2.2.1. Alternatives

2.2.1.1. Alternatives for Proposed Western Gulf Sales 204, 207, 210, 215, and 218

Alternative A — The Proposed Actions: This alternative would offer for lease all unleased blocks within the WPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary; and

(2) whole and partial blocks that lie within the 1.4-nautical mile (nmi) buffer zone north of the continental shelf boundary between the U.S. and Mexico, for Sales 204, 207, 210, and 215 only.

The WPA encompasses about 28.7 million acres (ac). The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.242-0.423 billion barrels of oil (BBO) and 1.644-2.647 trillion cubic feet (Tcf) of gas.

Alternative B — The Proposed Actions Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the WPA, as described for the proposed actions, with the exception of any unleased blocks subject to the Topographic Features Stipulation.

Alternative C — Use of a Nomination and Tract Selection Leasing System: This alternative would offer for lease for each proposed action a maximum of 300 industry-nominated blocks and offer all blocks that become available for leasing after the industry nomination deadline and before the Final Notice of Sale (FNOS) is published for that proposed action. The same exclusions described under Alternative A would apply. The number of blocks offered would be about 25 percent of the blocks estimated to be offered under an areawide leasing system (Alternative A); it is estimated that this alternative would result in a 25 percent reduction in the number of blocks leased per proposed action.

Alternative D — No Action: This is the cancellation of one or more proposed WPA lease sales. The opportunity for development of the estimated 0.242-0.423 BBO and 1.644-2.647 Tcf of gas that could have resulted from a proposed WPA lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed. This is analyzed in the Draft EIS for the 5-Year Program.

2.2.1.2. Alternatives for Proposed Central Gulf Sales 205, 206, 208, 213, 216, and 222

Alternative A — The Proposed Actions: This alternative would offer for lease all unleased blocks within the CPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) blocks that were previously included within the Eastern Planning Area (EPA) and that are within 100 mi of the Florida coast;

(2) blocks that were previously included within the EPA and that are under an existing Presidential withdrawal through 2012, as well as subject to annual congressional moratoria;

(3) blocks that are beyond the U.S. Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(4) whole and partial blocks that lie within the 1.4-nmi buffer zone north of the continental shelf boundary between the U.S. and Mexico, for Sales 205, 206, 208, and 213 only.

The CPA sale area encompasses about 58.7 million ac of the CPA's 66.3 million ac. The estimated amount of resources projected to be developed as a result of any one proposed CPA lease sale is 0.776-1.292 BBO and 3.236-5.229 Tcf of gas.

Alternative B — The Proposed Actions Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed actions, with the exception of any unleased blocks subject to the Topographic Features Stipulation.

Alternative C — The Proposed Actions Excluding the Unleased Blocks Within 15 Miles of the Baldwin County, Alabama, Coast: This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed actions, with the exception of any unleased blocks within 15 mi of the Baldwin County, Alabama, coast.

Alternative D — Use of a Nomination and Tract Selection Leasing System: This alternative would offer for lease for each proposed action a maximum of 1,000 industry-nominated blocks and offer all blocks that become available for leasing after the industry nomination deadline and before the FNOS is published for that proposed action. The same exclusions described under Alternative A would apply. The number of blocks offered would be about 25 percent of the blocks estimated to be offered under an areawide leasing system (Alternative A); it is estimated that this alternative would result in a 25 percent reduction in the number of blocks leased per proposed action.

Alternative E — No Action: This alternative is the cancellation of one or more proposed CPA lease sales. The opportunity for development of the estimated 0.776-1.292 BBO and 3.236-5.229 Tcf of gas that could have resulted from a proposed CPA lease sale would be precluded or postponed. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed. This is analyzed in the Draft EIS for the 5-Year Program.

2.2.2. Mitigating Measures

In 1978, the Council on Environmental Quality (CEQ) defined mitigation as a 5-step process.

- Avoidance—The avoidance of an impact altogether by not taking a certain action or part of an action.
- Minimization—The minimizing of impacts by limiting the degree or magnitude of the action and its implementation.
- Restoration—The rectifying of the impact by repairing, rehabilitation, or restoring the affected environment.
- Maintenance—The reducing or eliminating of the impact over time by preservation and maintenance operations during the life of the action.
- Compensation—The compensation for the impact by replacing or providing substitute resources or environments.

2.2.2.1. Proposed Mitigating Measures Analyzed

The potential mitigating measures included for analysis in this EIS were developed as the result of scoping efforts over a number of years for the continuing OCS Program in the GOM. Four lease stipulations are proposed for the WPA sales—the Topographic Features Stipulation, the Military Areas Stipulation, the Operations in the Naval Mine Warfare Area Stipulation, and the Protected Species Stipulation. Seven lease stipulations are proposed for all the Central Gulf sales—the Topographic Features Stipulation, the Live Bottom Stipulation, the Military Areas Stipulation, the Evacuation Stipulation, the Coordination Stipulation, the Blocks South of Baldwin County, Alabama Stipulation, and the Protected Species Stipulation. These measures will be considered for adoption by the Assistant Secretary of the Interior for Land and Minerals (ASLM). The analysis of any stipulations as part of Alternative A does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from any proposed lease sale nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions change.

Any stipulations or mitigation requirements to be included in a lease sale will be described in the Record of Decision for that lease sale. Mitigation measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease. In addition, each exploration and development plan, as well as any pipeline applications that may result from a lease sale, will undergo a NEPA review, and additional project-specific mitigations may be applied as conditions of plan approval. The MMS has the authority to monitor and enforce these conditions, and under 30 CFR 250 Subpart N, may seek remedies and penalties from any operator that fails to comply with the conditions of permit approvals, including stipulations and other mitigating measures.

2.2.2.2. Existing Mitigating Measures

Mitigating measures have been proposed, identified, evaluated, or developed through previous MMS lease sale NEPA review and analysis. Many of these mitigating measures have been adopted and incorporated into regulations and/or guidelines governing OCS exploration, development, and production activities. All plans for OCS activities go through rigorous MMS review and approval to ensure compliance with established laws and regulations. Mitigating measures must be incorporated and documented in plans submitted to MMS. Operational compliance is enforced through the MMS on-site inspection program.

Mitigating measures that are a standard part of the MMS program ensure that the operations are always conducted in an environmentally sound manner (with a zero tolerance of pollution and with every regulatory effort to minimize any adverse impact of routine operations to the environment), site clearance procedures to eliminate potential snags to commercial fishing nets and require surveys to detect and avoid archaeological sites and biologically-sensitive areas such as pinnacles, low-relief live bottoms, and chemosynthetic communities.

Some MMS-identified mitigating measures are incorporated into OCS operations through cooperative agreements or efforts with industry and various State and Federal agencies. These mitigating measures include NOAA Fisheries Service's Observer Program to protect marine mammals and sea turtles during explosive removals, regulations on minimum helicopter altitudes to prevent disturbance of wildlife, labeling operational supplies to track possible sources of accidental debris loss, development of methods of pipeline landfall to eliminate impacts to barrier beaches, and semiannual beach cleanup events.

2.2.3. Issues

Issues are defined by CEQ to represent those principal "effects" that an EIS should evaluate in-depth. Scoping identifies specific environmental resources and/or activities rather than "causes" as significant issues (CEQ Guidance on Scoping, April 30, 1981). The analysis in the EIS can then show the degree of change from present conditions for each issue due to the relevant actions related to the proposed actions.

Selection of environmental and socioeconomic issues to be analyzed was based on the following criteria:

- issue is identified in CEQ regulations as subject to evaluation;
- the relevant resource/activity was identified through the scoping process or from comments on past EIS's;
- the resource/activity may be vulnerable to one or more of the impact-producing factors (IPF) associated with the OCS Program; a reasonable probability of an interaction between the resource/activity and IPF should exist; or
- information that indicates a need to evaluate the potential impacts to a resource/activity has become available.

2.2.3.1. Issues to be Analyzed

The following issues relate to potential IPF's and the resources and activities that could be affected by OCS exploration, development, production, and transportation activities.

Accidental Events: Concerns were raised related to the potential impact of oil spills on the marine and coastal environments specifically regarding the potential effects of oil spills on tourism, emergency response capabilities, spill prevention, effect of winds and currents on the transport of oil spills, accidental discharges from both deepwater blowouts and pipeline ruptures, and oil spills resulting from past and future hurricanes. Other concerns raised over the years of scoping were the fate and behavior of oil spills, availability and adequacy of oil-spill containment and cleanup technologies, oil-spill cleanup strategies, impacts of various oil-spill cleanup methods, effects of weathering on oil spills, toxicological effects of fresh and weathered oil, air pollution associated with spilled oil, and short-term and long-term impacts of oil on wetlands.

Drilling Fluids and Cuttings: Specific concerns related to drilling fluids include mercury, synthetic-based drilling fluids (SBF) and large volumes of industrial chemicals necessary for deepwater drilling operations, and potential for persistence of drilling muds and cuttings. Other concerns raised over the years of scoping were potential smothering of benthic communities by offshore disposal of drilling fluids and cuttings, the use and disposal of drilling fluids include potential spills of oil-based drilling fluids (OBF), onshore disposal of OBF, the fate and effects of SBF's in the marine environment, and the potential toxic effects or bioaccumulation of trace metals in drilling fluids discharged into the marine environment.

Visual and Aesthetic Interference: Lighting was raised as a specific concern. Concerns raised over the years of scoping were the potential effects of the presence of drilling rigs and platforms, service vessels, helicopters, trash and debris, and flaring on visual aesthetics.

Air Emissions: The potential effects of emissions of combustion gases from platforms, drill rigs, service vessels, and helicopters have been raised as an issue over the years of scoping. Also under consideration are the flaring of produced gases during extended well testing and the potential impacts of transport of production with associated H_2S.

Water Quality Degradation: Issues related to water quality degradation raised over the years of scoping most often were associated with operational discharges of drilling muds and cuttings, produced waters, and domestic wastes. Water quality issues also included concerns related to impacts from sediment disturbance, petroleum spills and blowouts, and discharges from service vessels.

Other Wastes: Other concerns raised over the years of scoping include storage and disposal of trash and debris, and trash and debris on recreational beaches.

Structure and Pipeline Emplacement: Some of the issues raised over the years of scoping related to structure and pipeline emplacement are bottom area disturbances from bottom-founded structures or anchoring, sediment displacement related to pipeline burial, space-use conflicts, and the vulnerability of offshore pipelines to damage that could result in hydrocarbon spills or H_2S leaks.

Platform Removals: Concerns raised over the years of scoping about the abandonment of operations include how a platform is removed, potential impacts of explosive removals on marine organisms, remaining operational debris snagging fishing nets, and site clearance procedures.

OCS-Related Support Services, Activities, and Infrastructure: Specific issues were damage to coastal infrastructure by Hurricanes Katrina and Rita, and the vulnerability of coastal infrastructure to damage from future hurricanes. Concerns raised over the years of scoping include activities related to the shore-base support of the Development and Production Plan include vessel and helicopter traffic and emissions, construction or expansion of navigation channels or onshore infrastructure, maintenance and use of navigation channels and ports, and deepening of ports.

Sociocultural and Socioeconomic: Many concerns have focused on the potential impacts to coastal communities including demands on public services and tourism. Issues raised over the years of scoping include impacts on employment, population fluctuations, effects on land use impacts to low-income or minority populations, and cultural impacts.

OCS Oil and Gas Infrastructure: Specific issues were damage to offshore infrastructure by Hurricanes Katrina and Rita, and the vulnerability of offshore infrastructure to damage from future hurricanes.

Other Issues: Many other issues have been identified. Several of these issues are subsets or variations of the issues listed above. All are taken under advisement and are considered in the analyses, if appropriate. Additional issues raised during the years of scoping are new and unusual technologies, noise from platforms, vessels, helicopters, and seismic surveys; turbidity as a result of seafloor disturbance or discharges; mechanical damage to biota and habitats; and multiple-use conflicts.

Resource Topics Analyzed in the EIS: The analyses in **Chapters 4.2, 4.4, and 4.5** address the issues and concerns identified above under the following resource topics:

–Air Quality
–Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice
–Archaeological Resources (Historic and Prehistoric)
–Coastal Barrier Beaches and Associated Dunes
–Coastal and Marine Birds
–Commercial Fisheries
–Continental Shelf Benthic Resources (Live-Bottom and Topographic Features)
–Continental Slope and Deepwater Resources (Chemosynthetic and Nonchemosynthetic Communities)
–Fish Resources and Essential Fish Habitat
–Gulf Sturgeon
–Human Resources and Land Use
–Live Bottoms (Pinnacle Trend)
–Marine Mammals
–Recreational Fishing
–Recreational Resources (Beach Use, Visual Aesthetics, and Tourism)
–Sea Turtles
–Submerged Vegetation
–Topographic Features
–Water Quality (Coastal and Marine)
–Wetlands

2.2.3.2. Issues Considered but Not Analyzed

As previously noted, the Council on Environmental Quality's (CEQ's) regulations for implementing NEPA instruct agencies to adopt an early process (termed "scoping") for determining the scope of issues to be addressed and for identifying significant issues related to a proposed action. As part of this scoping process, agencies shall identify and eliminate from detailed study the issues that are not significant to the proposed action or have been covered by prior environmental review.

Through our scoping efforts, numerous issues and topics were identified for consideration in the EIS for the proposed 2007-2012 Western and Central lease sales. After careful evaluation and study, the following categories were considered not to be significant issues related to the proposed actions or that have been covered by prior environmental review.

Program and Policy Issues

Comments and concerns that relate to program and policy are issues under the direction of the Department of the Interior and/or MMS, and their guiding regulations, statutes, and laws. The comments and concerns related to program and policy issues are not considered to be specifically related to the proposed actions and are forwarded to the appropriate program offices for their consideration. Programmatic issues including expansion of the sale areas, administrative boundaries, and royalty relief have been considered in the preparation of the Draft EIS for the 5-Year Program.

Revenue Sharing

A number of comments were received from State and local governments, interest groups, and the general public stating that locally affected communities should receive an increased share of revenues generated by the OCS oil and gas leasing program. This increased revenue would act as mitigation of OCS-related impacts to coastal communities including impacts to LA Hwy 1 and Lafourche Parish, Louisiana, from OCS-related activity at Port Fourchon. Comments and concerns that relate to the use and distribution of revenues are issues under the direction of the Congress of the U.S. or the Department of the Interior, and their guiding regulations, statutes, and laws.

The MMS distributes revenues collected from Federal mineral leases to special-purpose funds administered by Federal agencies; to States; and to the General Fund of the U.S. Department of the Treasury. Legislation and regulations provide formulas for the disbursement of these revenues. Current distribution of revenues is discussed in **Chapter 3.3.5.2**. Congress is currently reviewing legislation that would modify the distribution of revenues generated by the OCS oil and gas leasing program.

The socioeconomic benefits and impacts to local communities are analyzed in **Chapter 4** of this EIS.

2.3. PROPOSED WESTERN GULF LEASE SALES 204, 207, 210, 215, AND 218

2.3.1. Alternative A — The Proposed Actions

2.3.1.1. Description

Alternative A would offer for lease all unleased blocks within the WPA for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary; and

(2) whole and partial blocks that lie within the 1.4-nmi buffer zone north of the continental shelf boundary between the U.S. and Mexico, for Sales 204, 207, 210, and 215 only.

The WPA encompasses about 28.7 million ac. The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.242-0.423 BBO and 1.644-2.647 Tcf of gas.

The analyses of impacts summarized below and described in detail in **Chapters 4.2.1 and 4.4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapters 4.1.1, 4.1.2, and 4.3**.

2.3.1.2. Summary of Impacts

Air Quality

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are expected to be well within the NAAQS. A proposed action would have only a small effect on ozone levels in ozone nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the Prevention of Significant Deterioration (PSD) Class II areas.

Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications.

Water Quality

Coastal Waters

The primary impacting sources to water quality in coastal waters are point-source and storm water discharges from support facilities, vessel discharges, and nonpoint-source runoff. The impacts to coastal water quality from a proposed action should be minimal as long as all existing regulatory requirements are met.

The ability of coastal waters to assimilate spilled oil is affected by the shallowness of the environment. Large volumes of water are not available to dilute suspended oil droplets and dissolved constituents. Since oil does not mix with water and is usually less dense, most of the oil forms a slick at the surface. Small droplets in the water may adhere to suspended sediment and be removed from the water column. Oil contains toxic aromatic compounds such as benzene, toluene, xylenes, naphthalenes, and polynuclear aromatic hydrocarbons, which are soluble to some extent in water. The effect of these compounds on water quality depends on the circulation in the coastal environment, the composition of the spilled oil, and the length of time the oil is in contact with the water. Oil may also penetrate sand on the beach or be trapped in wetlands, where it can be re-released into the water some time after the initial spill.

Marine Waters

During exploratory activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. During installation activities, the primary impacting sources to water quality are sediment disturbance and turbidity. Impacting discharges during production activities are produced water and supply-vessel discharges. Regulations are in place to limit the levels of contaminants in these discharges. During platform removal, sediment disturbance, gaseous by-products of explosives or abrasive grit from cuttings are the impacting discharges. Impacts to marine waters from a proposed action should be minimal as long as regulatory requirements are followed.

Smaller spills (<1,000 bbl) are not expected to significantly impact water quality in marine and coastal waters. Larger spills, however, could impact water quality especially in coastal waters. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary localized impacts on water quality.

Sensitive Coastal Environments

Coastal Barrier Beaches and Associated Dunes

In summary, effects to coastal barrier beaches and associated beaches from pipeline emplacements, navigation channel use and dredging, and construction or continued use of infrastructure in support of a proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 gas processing plants and 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action.

Wetlands

A proposed action in the WPA is projected to contribute to the construction of 0-1 new onshore pipelines. Modern pipelaying techniques and mitigations would be used for such a project and thus, the projected impact to wetlands from pipeline emplacement is expected to be negligible. As a secondary impact, some wetlands could potentially be converted to open water by continued widening of existing pipeline and navigational canals.

Maintenance dredging of navigation channels related to a proposed action is expected to occur with minimal impacts. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands.

Deepening an existing channel to accommodate larger service vessels may occur within the previously described environment(s) and could generate the creation of a small area of wetland that would be attributable to a proposed action.

Overall, activities associated with a proposed action in the WPA are expected to cause negligible to low impacts to wetlands. Secondary impacts to wetlands caused by existing pipeline and vessel traffic corridors will continue to cause landloss. However, their broad and diffuse distribution over coastal Texas makes it difficult to distinguish these impacts from other ongoing, non-OCS-related impacts to wetlands.

Offshore oil spills resulting from a proposed action are not expected to damage significantly any wetlands along the Gulf Coast. However, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in Galveston County and Matagorda County, Texas, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes, Louisiana in the CPA.

Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment and personnel used to clean up a slick over the impacted area may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. Overall, impacts to wetland habitats from an oil spill associated with activities related to a proposed action would be expected to be low and temporary.

Seagrass Communities

Most seagrass communities located within a WPA proposed action are located behind the barrier islands. These are sparsely distributed in bays and estuaries along coastal Texas, including the Laguna Madre of Tamaulipas, Mexico. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat. The potential impacts from oil spills are discussed in **Chapter 4.4.2.3**.

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Therefore, impacts to submerged vegetation by pipeline installation are projected to be very small and short term. **Table 4-9** lists the projected number of additional OCS pipeline landfalls and their inshore lengths to be constructed as a result of a WPA proposed action.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a navigation channel's area of influence will have already adjusted their bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area or damage to an already stressed area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a WPA proposed action.

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities with the highest probabilities of contact within 10 days would be those located within Matagorda County, Texas, for a proposed action in the WPA and Plaquemines Parish, Louisiana, for a proposed action in the CPA.

Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb to the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Although the probability of their occurrence is low, the greatest threat to inland, seagrass communities would be from an inland spill resulting from a vessel accident or pipeline rupture. Although a resulting slick may cause minor impacts to the bed, equipment and personnel used to clean up a slick over shallow seagrass beds may generate the greatest direct impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Sensitive Offshore Benthic Resources

Topographic Features

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

The proposed Topographic Features Stipulations will assist in preventing most of the potential topographic feature communities from blowouts and surface and subsurface oil spills. Recovery from incidences of impacts from blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulations would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Chemosynthetic Deepwater Benthic Communities

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment in the same locations.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience very minor (if any) impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type). There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried by resuspended sediments from a blowout.

Potential accidental impacts from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities located at more than 1,500 ft away from a blowout could experience minor impacts from resuspended sediments.

Nonchemosynthetic Deepwater Benthic Communities

Some impact to soft-bottom benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic infaunal communities occurred, recolonization from populations from neighboring soft bottom substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be relatively rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities. Impacts to other hard bottom communities are expected to be avoided as a consequence of the application of the existing NTL 2000-G20 for chemosynthetic communities. The same geophysical conditions associated with the potential presence of chemosynthetic communities also results in hard carbonate substrate that is generally avoided.

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of hours to days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities will likely be avoided as a consequence of the application of NTL 2000-G20 and the similar geophysical signatures (hard bottom) indicating the potential presence of chemosynthetic communities.

Accidental events from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities.

Marine Mammals

Small numbers of marine mammals could be killed or injured by a chance collision with a service vessel; however, current MMS requirements and guidelines for vessel operation in the vicinity of protected species should minimize this risk (i.e., the proposed Protected Species Lease Stipulation and NTL 2003-G10).

Marine mammal ingestion of industry-generated debris is a concern. Sperm whales may be particularly at risk because of their suspected feeding behavior involving cruising along the bottom with their mouth open. Entanglement in debris could have serious consequences. A sperm whale could suffer diminished feeding and reproductive success, and potential injury, infection, and death from entanglement in discarded packing materials or debris. Industry has made good progress in debris management on vessels and offshore structures in the last several years. The debris awareness training, instruction, and placards required by the proposed Protected Species Lease Stipulation and NTL 2003-G11 should greatly minimize the amount of debris that is accidentally lost overboard by offshore personnel.

There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Noise associated with a proposed action, including drilling noise, aircraft, and vessels, may affect marine mammals by eliciting a startle response or masking other sounds. However, many of the industry-related sounds are believed to be out of, or on the limits of, marine mammal hearing, and the sounds are also generally temporary. The continued presence of sperm whales in close proximity to some of the deepwater structures in the GOM tends to rule out concerns of permanent displacement from disturbance.

Seismic operations have the potential to harm marine mammals in close proximity to firing airgun arrays. The proposed protected species lease stipulations and the several mitigations, including onboard observers and airgun shut-downs for whales in the exclusion zone, included in NTL 2004-G01 (“Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program”) minimize the potential of harm from seismic operations to marine mammals.

Marine mammal death or injury is not expected from explosive structure removal operations. Existing mitigations and those recently developed for structures placed in oceanic waters should continue to minimize adverse effects to marine mammals from these activities.

Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification. Although the scope and magnitude of such effects are not known, direct or indirect effects are not expected to be lethal.

Routine activities related to a proposed action, particularly when mitigated as required by MMS, are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population endemic to the northern GOM.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the GOM. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents, characteristics of spilled oil, spill-response capabilities and timing, and various meteorological and hydrological factors. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in harassment, harm, or mortality to marine mammals occurring in the northern Gulf. Marine mammals made no apparent attempt to avoid spilled oil in some cases (e.g., Smultea and Würsig, 1995); however, marine mammals have been observed apparently detecting and avoiding slicks in other reports (e.g., Geraci and St. Aubin, 1987). Exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick is likely to result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to marine mammals.

Sea Turtles

Routine activities resulting from a proposed action have the potential to harm sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by seismic exploration, helicopter and vessel traffic, platforms, and drillships; vessel collisions; and marine debris generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. Most OCS activities are expected to have sublethal effects.

Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification but there is uncertainty concerning the possible effects. Rapid dilution of the discharges should minimize impact. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas from noise disturbance could cause declines in survival or fecundity, and result in population declines; however, such declines are not expected. The required seismic operation mitigations, particularly clearance of the impact area of sea turtles and marine mammals prior to ramp-up, and the subsequent gradual ramping up of the airguns, should minimize the impact of rapid onset of, and close proximity to, very loud noise. Vessel traffic is a serious threat to sea turtles. Diligence on the part of vessel operators as encouraged by the vessel strike mitigations should minimize vessel/sea turtle collisions. Actual sea turtle impacts from explosive removals in recent years have been small. The updated pre- and post-detonation mitigations should insure that injuries remain extremely rare. Greatly improved handling of waste and trash by industry, along with the annual awareness training required by the marine debris mitigations, is decreasing the plastics in the ocean and minimizing the devastating effects on sea turtles. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the GOM.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to sea turtles occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to sea turtles. Sea turtle hatchling exposure to, fouling by, or consumption of tarballs persisting in the sea following the dispersal of an oil slick by would likely be fatal.

Coastal and Marine Birds

The majority of effects resulting from a proposed action in the WPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts from pipeline and navigation canals to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigated waterways can contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

Fish Resources and Essential Fish Habitat

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will experience little or no impact. Live bottoms within No Activity Zones will be completely avoided by all impacting activities. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

Additional hard substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase fish populations. Removal of these structures will eliminate that habitat except when decommissioning results in platforms being used as artificial reef material. This practice is expected to increase over time.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

Law and Hellou (1999) make a clear summary stating, “Accidents and spillages are an inevitable consequence of the worldwide transport of crude oil and refined petroleum products by sea.” They also add that the number of major spills occurring each year has decreased since the 1970’s. Accidental events resulting from oil and gas development in a proposed action area of the GOM have the potential to cause some detrimental effects on fisheries and commercial fishing practices. A subsurface blowout would have a negligible effect on GOM fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Historically, there have been no oil spills of any size that have had a long-term impact on fishery populations. Any affected commercial fishing activity would recover within 6 months. There is no evidence at this time that commercial fisheries in the GOM have been adversely affected on a regional population level by spills or chronic contamination.

At the expected level of impact, the resultant influence on fish populations and commercial fishing activities from a proposed action would be negligible and indistinguishable from variations due to natural causes. It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Commercial Fishing

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Seismic surveys are not expected to cause long-term or permanent displacement of any listed species from critical habitat/preferred habitat or to result in destruction or adverse modification of critical habitat or essential fish habitat. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

Law and Hellou (1999) make a clear summary stating, "Accidents and spillages are an inevitable consequence of the worldwide transport of crude oil and refined petroleum products by sea." They also add that the number of major spills occurring each year has decreased since the 1970's. Accidental events resulting from oil and gas development in a proposed action area of the GOM have the potential to cause some detrimental effects on fisheries and commercial fishing practices. A subsurface blowout would have a negligible effect on GOM fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Historically, there have been no oil spills of any size that have had a long-term impact on fishery populations. Any affected commercial fishing activity would recover within 6 months. There is no evidence at this time that commercial fisheries in the GOM have been adversely affected on a regional population level by spills or chronic contamination.

At the expected level of impact, the resultant influence on fish populations and commercial fishing activities from a proposed action would be negligible and indistinguishable from variations due to natural causes. It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Recreational Fishing

The development of oil and gas in the proposed lease sale area could attract additional recreational fishing activity to structures installed on productive leases. Each structure placed in the GOM to produce oil or gas would function as a *de facto* artificial reef, attract sport fish, and improve fishing prospects in the immediate vicinity of platforms. This impact would last for the life of the structure, until the structures are removed from the location and the marine environment. A proposed action would have a beneficial effect on offshore and deep-sea recreational fishing within developed leases accessible to fishermen. These effects would last until the production structures are removed from the marine environment. Short-term space-use conflict could occur during the time that any pipeline is being installed.

The estimated number and size of potential spills associated with a proposed action's activities are unlikely to decrease recreational fishing activity but may divert the location or timing of a few planned fishing trips. Potential recreational fisheries due to accidental events as a result of a proposed action would be minor to moderate. Based on the sizes of oil spills assumed for a proposed action, only localized and short-term disruption of recreational fishing activity might result (minor impact).

Recreational Resources

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short-term and localized. Should a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill result in a large volume of oil contacting a beach or a large recreational area being contacted by an oil slick, visitation to the area could be reduced by as much as 5-15 percent for as long as one season, but such an event should have no long-term effect on tourism.

Tarballs can lessen the enjoyment of the recreational beaches but should have no long-term effect on the overall use of beaches.

Archaeological Resources

Historic

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the WPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Pearson et al., 2003) resulted in refinement of the areas assessed as having high potential for historic period shipwrecks. An MMS review of the historic high-potential areas is occurring at the time of this writing. The NTL for archaeological resource surveys in the GOM Region, NTL 2005-G07, mandates a 50-m linespacing for remote-sensing surveys of leases within areas having high potential for historic shipwrecks in water depths 200 m (656 ft) or less, and 300-m linespacing in water depths greater than 200 m (656 ft). NTL 2006-G07 identifies those lease blocks that have been designated as having a high potential for containing historic shipwrecks.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the WPA are not expected to impact historic archaeological resources. It is conservatively assumed that about 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action (**Table 4-9**). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the WPA are not expected to affect historic archaeological resources.

Impact to a historic archaeological resource could occur as a result of an accidental spill. As indicated in **Chapter 4.3.1.7**, it is not very likely that an oil spill will occur and contact coastal historic archaeological sites from accidental events associated with a proposed action. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

Prehistoric

Several impact-producing factors may threaten the prehistoric archaeological resources of the Western Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant and/or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the WPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

Accidental events producing oil spills may threaten the prehistoric archaeological resources of the Gulf Coast. Impacts to prehistoric sites could occur as a result of an oil spill. Should a spill contact an archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

As indicated in **Chapter 4.3.1.7**, it is not very likely for an oil spill to occur and contact coastal and barrier island prehistoric sites as a result of a proposed action. The proposed actions are not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

Human Resources and Land Use

Land Use and Coastal Infrastructure

Chapters 3.3.5.3 and 3.3.5.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. Except for the projected 0-1 new gas processing plants, the proposed action will require no new oil and gas coastal infrastructure. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle development. There is also sufficient land to construct the projected new gas processing plant in the analysis area.

The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed WPA lease sale would not alter the current land use of the area.

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring clean up of any oil or chemicals spilled.

Demographics

Activities relating to a proposed WPA lease sale are expected to affect minimally the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one EIA. Baseline patterns and distributions of these factors, as described in C**hapter 3.3.5.4**, are expected to approximately maintain the same level. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

Economic Factors

Should a proposed WPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, Alabama, and Florida EIA's. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force for reasons discussed above.

The short-term social and economic consequences for the Gulf coastal region should a spill ≥1,000 bbl occur includes opportunity cost of employment and expenditures that could have been gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill.

Environmental Justice

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a proposed action in the WPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on these populations.

Future changes in activity levels will most likely be caused by fluctuations in oil prices and imports, and not by activities related to a proposed action. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

Considering the low likelihood of an oil spill and the heterogeneous population distribution along the GOM region, accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

2.3.1.3. Mitigating Measures

2.3.1.3.1. Topographic Features Stipulation

The topographic features located in the WPA provide habitat for coral-reef-community organisms (**Chapter 3.2.2.1.2**). Oil and gas activities resulting from the proposed actions could have a severe, even lethal, impact on or near these communities if the Topographic Features Stipulation is not adopted and such activities were not otherwise mitigated. The DOI has recognized this problem for some years, and since 1973 stipulations have been made a part of leases on or near these biotic communities; impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation would not prevent the recovery of oil and gas resources but would serve to protect valuable and sensitive biological resources.

The Topographic Features Stipulation was formulated based on consultation with various Federal agencies and comments solicited from the States, industry, environmental organizations, and academic representatives. The stipulation is based on years of scientific information collected since the inception of the stipulation. This information includes various Bureau of Land Management/MMS-funded studies of topographic highs in the GOM; numerous stipulation-imposed, industry-funded monitoring reports; and the National Research Council (NRC) report entitled *Drilling Discharges in the Marine Environment* (1983). The location of the blocks affected by the Topographic Features Stipulation is shown on **Figure 2-1**.

The requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer confines the effluent to a level deeper than that of the living components of a high-relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high-relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NRC, 1983).

(b) The biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 meters (m) of the discharge (NRC, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef-building activity (Rezak and Bright, 1981; Rezak et al., 1983 and 1985).

The stipulation establishes No Activity Zones at the topographic features. A zone is defined by the 85-m bathymetric contour (isobath) because, generally, the biota shallower than 85 m (279 ft) are more typical of the Caribbean reef biota, while the biota deeper than 85 m are similar to soft-bottom organisms found throughout the Gulf. Where a bank is in water depths less than 85 m, the deepest "closing" isobath defines the No Activity Zone for that topographic feature. Within the No Activity Zones, no operations, anchoring, or structures are allowed. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted.

The stipulation requires that all effluents within 1,000 m (3,281 ft) of banks containing an antipatharian-transitional zone be shunted to within 10 m (33 ft) of the seafloor. Banks containing the more sensitive and productive algal-sponge zone require a shunt zone extending 1 nmi and an additional 3-nmi shunt zone for development only.

Exceptions to the general stipulation are made for the Flower Garden Banks and the low-relief banks. Because the East and West features of the Flower Garden Banks have received National Marine Sanctuary status, they are protected to a greater degree than the other banks. The added provisions at the Flower Garden Banks require that (a) the No Activity Zone be based on the 100-m isobath instead of the 85-m isobath and be defined by the "1/4 1/4 1/4" system (a method of defining a specific portion of a block) rather than the actual isobath and (b) there be a 4-Mile Zone instead of a 1-Mile Zone in which shunting is required. Although Stetson Bank was made part of the Flower Garden Banks National Marine Sanctuary in 1996, it has not as yet received added protection that would differ from current stipulation requirements. Low-relief banks have only a No Activity Zone. A shunting requirement would be counterproductive because it would put the potentially toxic drilling muds in the same water depth range as the features associated biota that are being protected. Also, the turbidity potentially caused by the release of drilling effluents in the upper part of the water column would not affect the biota on low-relief features as they appear to be adapted to high turbidity. Claypile Bank, which is a low-relief bank that exhibits the *Millepora*-sponge community, has been given the higher priority protection of a 1,000-Meter Zone where monitoring is required.

The stipulation reads as follows:

Topographic Features Stipulation

(a) No activity including structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the leases on banks as listed above.

(b) Operations within "1,000-Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

(c) Operations within "1-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom. (Where there is a "1-Mile Zone" designated, the "1,000-Meter Zone" in paragraph (b) is not designated.) This restriction on operations also applies to areas surrounding the Flower Garden Banks National Marine Sanctuary, namely the "4-Mile Zone" surrounding the East Flower Garden Bank and the West Flower Garden Bank.

(d) Operations within "3-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

The banks and corresponding blocks to which this stipulation may be applied in the WPA are as follows:

Bank Name	Isobath (m)	Bank Name	Isobath (m)	Bank Name	Isobath (m)
Shelf Edge Banks		Low-Relief Banks[2]		South Texas Banks[4]	
West Flower Garden Bank	100	Mysterious Bank	74, 76, 78, 80, 84	Dream Bank	78, 82
(defined by ¼ ¼ ¼ system)		Coffee Lump	Various	Southern Bank	80
East Flower Garden Bank	100	Blackfish Ridge	70	Hospital Bank	70
(defined by ¼ ¼ ¼ system)		Big Dunn Bar	65	North Hospital Bank	68
MacNeil Bank	82	Small Dunn Bar	65	Aransas Bank	70
29 Fathom Bank	64	32 Fathom Bank	52	South Baker Bank	70
Rankin Bank	85	Claypile Bank[3]	50	Baker Bank	70
Bright Bank[1]	85				
Stetson Bank	52				
Appelbaum Bank	85				

[1]CPA bank with a portion of its "3-Mile Zone" in the WPA.
[2]Low-Relief Banks—only paragraph (a) of the stipulation applies.
[3]Claypile Bank—only paragraphs (a) and (b) of the stipulation apply. In paragraph (b), monitoring of the effluent to determine the effect on the biota of Claypile Bank shall be required rather than shunting.
[4]South Texas Banks—only paragraphs (a) and (b) of the stipulation apply.

Effectiveness of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from adverse effects due to routine oil and gas activities. Such effects include physical damage from anchoring and rig emplacement and potential toxic and smothering effects from muds and cuttings discharges. The Topographic Features Stipulation has been used on leases since 1973 and has effectively prevented damage to the biota of these banks from routine oil and gas activities such as anchoring. Monitoring studies have demonstrated that the shunting requirements of the stipulation are effective in preventing the muds and cuttings from impacting the biota of the banks. The stipulation, if adopted for the proposed actions, will continue to protect the biota of the banks, specifically as discussed below.

The stipulation provides different levels of protection for banks in different categories as defined by Rezak and Bright (1981). The categories and their definitions are as follows:

Category A: zone of major reef-building activity; maximum environmental protection recommended;

Category B: zone of minor reef-building activity; environmental protection recommended;

Category C: zone of negligible reef-building activity, but crustose algae present; environmental protection recommended; and

Category D: zone of no reef-building or crustose algae; additional protection not necessary.

Mechanical damage resulting from oil and gas operations is probably the single most serious impact to benthic habitat. Complying with the No Activity Zone designation of the Topographic Features Stipulation should completely eliminate this threat to the sensitive biota of WPA topographic features from activities resulting from the proposed actions.

Several other impact-producing factors may threaten communities associated with topographic features. Vessel anchoring and structure emplacement result in physical disturbance of benthic habitat and are the most likely activities to cause permanent or long-lasting impacts to sensitive offshore habitats. Recovery from damage caused by such activities may take 10 or more years (depending on the maturity of the impacted community). Operational discharges (drilling muds and cuttings, produced waters) may impact the biota of the banks because of turbidity and sedimentation, resulting in death to benthic organisms in large areas. Recovery from such damage may take 10 or more years (depending on the maturity of the impacted community). Blowouts may cause similar damage to benthic biota by resuspending sediments, causing turbidity and sedimentation, which could ultimately have a lethal impact on benthic organisms. Recovery from such damage may take up to 10 years (depending on the maturity of the impacted community). Oil spills will cause damage to benthic organisms if the oil contacts the organisms; such contact is unlikely except from spills from blowouts. There have been very few blowouts in the Gulf. Structure removal using explosives can result in water turbidity, redeposition of sediments, and explosive shock-wave impacts. Recovery from such damage could take more than 10 years (depending on the maturity of the impacted community). The above activities, especially bottom-disturbing activities, have the greatest potential to severely impact the biota of topographic features. Those activities having the greatest impacts are also those most likely to occur. The proposed actions, without benefit of the Topographic Features Stipulation or comparable mitigation, are expected to have a severe impact on the sensitive offshore habitats of the topographic features.

The biota of low-relief banks and the turbidity of the water are such that protective measures to restrain drilling discharges are not warranted for these features.

The stipulation provides an added measure of protection for Claypile Bank, requiring both No Activity and 1,000-Meter Zones. Claypile Bank is the only low-relief bank that is known to contain the *Millepora*-sponge community. This assemblage is categorized by Rezak and Bright (1981) as a Category B community (minor reef-building activity) worthy of increased protection; therefore, monitoring will be required within the 1,000-Meter Zone. Any impacts from drilling will thereby be documented so that further protective measures could be taken. Due to the low relief of the bank (5 m), shunting would be counterproductive.

The stipulation requires that all drill cuttings and drilling fluids within 1,000 m of high-relief topographic features categorized by Rezak and Bright (1981) as Category C banks (negligible reef-building activity) be shunted into the nepheloid layer; the potentially harmful materials in drilling muds would be trapped in the bottom boundary layer and would not move up the banks where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m from the bank is not expected to adversely impact the biota.

The stipulation protects the remaining banks (Category A and B banks—major and minor reef building) with even greater restrictions. (Appelbaum Bank is categorized as Category C; however, it contains the algal-sponge community, which is indicative of Category A banks. Therefore, it carries a Category A bank stipulation.) Surface discharge will not be allowed within 1 nmi of these more sensitive banks. Surface discharges outside of 1 nmi are not expected to adversely impact the biota of the banks. However, when multiple wells are drilled from a single platform (surface location), which is typical during development operations, extremely small amounts of muds discharged more than 1 nmi from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged from numerous wells outside of 1 nmi, the stipulation imposes a 3-Mile Zone within which shunting of development effluent is required. The stipulation results in increased protection to the East and West features of the Flower Garden Banks. Shunting would be required within a 4-Mile Zone.

The surface discharge of drilling muds and cuttings resulting from exploratory wells within the 3-Mile Zone is not expected to reach or affect the biological resources located within the No Activity Zone for three main reasons: (1) the biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983); (2) exploration usually requires the drilling of one to four wells per site as opposed to more than five in the case of development; and (3) a significantly lower volume of exploration drilling discharges is expected per site since development usually requires the drilling of several additional wells over greater distances to reach potential reservoirs. The requirement to shunt drilling discharges within the 3-Mile Zone during development drilling is in response to the strong recommendation by FWS.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from the proposed actions, while allowing the development of nearby oil and gas resources. The stipulation would not protect the banks from adverse effects of an accident such as a large blowout on a nearby oil or gas operation.

2.3.1.3.2. Military Areas Stipulation

A standard military warning areas stipulation has been applied to all blocks leased in military areas in the GOM since 1977. **Figure 2-2** shows the military warning areas in the GOM. This stipulation would be a part of any lease resulting from the proposed actions. The stipulation reads as follows:

Military Areas Stipulation

(a) Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the OCS, to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the OCS, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States Government, its contractors or subcontractors, or any of its officers, agents or employees, being conducted as a part of, or in connection with, the programs and activities of the command headquarters listed at the end of this stipulation.

Notwithstanding any limitation of the lessee's liability in Section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, or to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

(b) Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of its agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters to the degree necessary to prevent damage to, or unacceptable interference with, Department of Defense flight, testing, or operational activities, conducted within individual designated warning areas. Necessary monitoring control, and coordination with the lessee, its agents, employees, invitees, independent contractors or subcontractors, will be effected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, independent contractors or subcontractors and onshore facilities.

(c) Operational

The lessee, when operating or causing to be operated on its behalf, boat, ship, or aircraft traffic into the individual designated warning areas, shall enter into an agreement with the commander of the individual command headquarters listed in the following list, upon utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats, ships, and aircraft operating into the warning areas at all times.

Effectiveness of the Lease Stipulation

The hold harmless section of the military stipulation serves to protect the U.S. Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and its agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and its agents to reduce and curtail the use of radio, CB, or other equipment emitting electromagnetic energy within some areas. This serves to reduce the impact of oil and gas activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of oil and gas activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers that will avoid the areas where oil and gas activities are taking place or to schedule around these activities. Prior notification helps reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

This stipulation reduces potential impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The reduction in potential impacts resulting from this stipulation makes multiple-use conflicts most unlikely. Without the stipulation, some potential conflict is likely. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and oil and gas activities.

2.3.1.3.3. Naval Mine Warfare Area Stipulation

This stipulation will apply to whole and partial blocks located in the Naval Mine Warfare Command Operational Area D (**Figure 2-1**). The Navy has identified these blocks as needed for testing equipment and for training mine warfare personnel. The MMS and the Navy have entered into a formal agreement (signed June 20, 1994, by the MMS and July 15, 1994, by the Navy) that these blocks could be offered for lease with a special stipulation. The stipulation reads as follows:

Naval Mine Warfare Area Stipulation

1. The provisions of this paragraph shall apply to all of Mustang Island Area East Addition Blocks 732, 733, and 734; and to those portions of Mustang Island Area Blocks 768, 769, 777, 778, 790, and 791 which are in Naval Mine Warfare Command Operational Area D.

    (a) <u>Exploration</u>: The placement, location, and planned periods of operation of surface structures on this lease (or portion as specified above) during the exploration stage are subject to approval by the Regional Director (RD), MMS GOM Region, after the review of the operator's Exploration Plan (EP). Prior to the submission of the EP, the lessee will consult with the Commander, Mine Warfare Command, in order to determine the EP's compatibility with scheduled military operations. The EP shall contain a statement certifying the consultation and indicating whether the Commander, Mine Warfare Command has any objection to activities and schedule of the EP. No permanent structures nor debris of any kind shall be allowed in the area covered by this lease during exploration operations.

(b) Development: Any above-seafloor development operations within the area covered by this lease (or portion as specified above) must be compatible with scheduled military operations as determined by the Commander, Mine Warfare Command. The lessee will consult with and coordinate plans for above-seafloor development activities (including abandonment) with the Commander, Mine Warfare Command. The Development Operations Coordination Document (DOCD) must contain the locations of any permanent structures, fixed platforms, pipelines, or anchors planned to be constructed or placed in the area covered by this lease (or portion as specified above) as part of such development operations. The DOCD must also contain the written comments of the Commander, Mine Warfare Command on the proposed activities. If the Commander, Mine Warfare Command determines that activities are incompatible, the RD will consult with him to resolve the matter. If no resolution can be reached, then development operations must be conducted from outside the Naval Mine Warfare Command Operational Area.

2. The provisions of this paragraph shall apply to those portions of Mustang Island Area Blocks 775, 798, 815, 821, and 822 which are in the Naval Mine Warfare Command operational transit lanes QJR 101, QJR 102, and QJR 105 as shown on the attached map and specified on the attached coordinates list.

(a) Exploration and Development: No operations, exploratory or development activities shall take place, nor will structures of any kind will be placed, in Naval Mine Warfare Command operational transit lanes QJR 101, QJR 102, and QJR 105.

3. The provisions of this paragraph shall apply to all of Mustang Island Area Blocks 793, 799, and 816.

(a) Exploration and Development: The lessee agrees that no activity including, but not limited to, construction and use of structures, operation of drilling rigs, laying of pipelines, and/or anchoring will occur or be located on the seabed or in the water column above or within any portion of this lease. All exploration, development, and production activities or operations must take place from outside the lease by the use of directional drilling or other techniques.

(b) Prior to the submission of Exploration Plans (EP) and Development Operations Coordination Documents (DOCD) for this lease, Lessee will consult with the Commander, Mine Warfare Command, in order to determine the compatibility of Lessee's plans with scheduled military operations. The EP and DOCD shall contain a statement certifying the consultation and indicating whether the Commander, Mine Warfare Command has any objection to activities and schedule of the EP or DOCD.

4. For more information, consultation, and coordination, the lessee must contact the Mine Warfare Command Commander.

(a) The placement, location, and planned periods of operation of surface structures on this lease during the exploration stage are subject to approval by the Regional Director (RD), Minerals Management Service, GOM Region, after the review of the operator's Exploration Plan (EP). Prior to approval of the EP, the RD will consult with the Commander, Mine Warfare Command, in order to determine the EP's compatibility with scheduled military operations. No permanent structures nor debris of any kind shall be allowed in the area covered by this lease during exploration operations.

(b) To the extent possible, sub-seafloor development operations for resources subsurface to this area should originate outside the area covered by this lease. Any above-seafloor development operations within the area covered by this lease must be compatible with scheduled military operations as determined by the Commander, Mine Warfare Command. The lessee will consult with and coordinate plans for above-seafloor development activities (including abandonment) with the Commander, Mine Warfare Command. The Development Operations Coordination Document (DOCD) must contain the locations of any permanent structures, fixed platforms, pipelines, or anchors planned to be constructed or placed in the area covered by this lease as part of such development operations. The DOCD must also contain the written comments of the Commander, Mine Warfare Command on the proposed activities. Prior to approval of the DOCD, the RD will consult with the Commander in order to determine the DOCD's compatibility with scheduled military operations.

For more information, consultation, and coordination, the lessee must contact the Mine Warfare Command Commander.

Effectiveness of the Lease Stipulation

The Naval Mine Warfare Area Stipulation will eliminate potential impacts from multiple-use conflicts on these blocks.

For exploration activities, the stipulation requires consultation with the Commander, Mine Warfare Command, prior to approval of any EP. Prior coordination will determine the compatibility of the proposed exploration operations with scheduled military operations and help mitigate potential impacts between surface structures and scheduled military activities.

For development activities, the stipulation requires that both sub-seafloor and above-seafloor development operations must be compatible with scheduled military operations. Consultation and coordination prior to approval of any DOCD will help mitigate potential impacts between development operations and military activities on these blocks.

2.3.1.3.4. Protected Species Stipulation

A protected species stipulation has been applied to all blocks leased in the GOM since 2001. This stipulation would be a part of any lease resulting from the proposed actions i.e., Sales 204, 207, 210, 215, and 218. The stipulation reads as follows:

Protected Species Stipulation

To reduce the potential taking of federally protected species (e.g., sea turtles, marine mammals, Gulf sturgeon, and other listed species):

(a) The MMS will condition all permits issued to lessees and their operators to require them to collect and remove flotsam resulting from activities related to exploration, development, and production of this lease.

(b) The MMS will condition all permits issued to lessees and their operators to require them to post signs in prominent places on all vessels and platforms used as a result of activities related to exploration, development, and production of this lease detailing the reasons (legal and ecological) why release of debris must be eliminated.

(c) The MMS will require that vessel operators and crews watch for marine mammals and sea turtles, reduce vessel speed to 10 knots or less when assemblages of cetaceans are observed and maintain a distance of 90 m or greater from whales, and a distance of 45 m or greater from small cetaceans and sea turtles.

(d) The MMS will require that all seismic surveys employ mandatory mitigation measures including the use of a 500-meter "exclusion zone" based upon the appropriate water depth, ramp-up and shut-down procedures, visual monitoring and reporting. Seismic operations must immediately cease when certain marine mammals are detected within the 500-meter exclusion zone. Ramp-up procedures and seismic surveys may be initiated only during daylight unless alternate monitoring methods approved by MMS are used.

(e) The MMS will require lessees and operators to instruct offshore personnel to immediately report all sightings and locations of injured or dead protected species (marine mammals and sea turtles) to the appropriate stranding network. If oil and gas industry activity is responsible for the injured or dead animals (e.g. because of a vessel strike), the responsible parties should remain available to assist the stranding network. If the injury or death was caused by a collision with your vessel, you must notify MMS within 24 hours of the strike.

(f) The MMS will require oil spill contingency planning to identify important habitats, including designated critical habitat, used by listed species (e.g. sea turtle nesting beaches, piping plover critical habitat), and require the strategic placement of spill cleanup equipment to be used only by personnel trained in less-intrusive cleanup techniques on beach and bay shores.

Lessees and operators will be instructed how to implement these mitigation measures in Notices to Lessees (NTL's).

Effectiveness of the Lease Stipulation

This stipulation was developed in consultation with NOAA Fisheries Service and FWS, and is designed to minimize or avoid potential adverse impacts to federally protected species.

2.3.2. Alternative B — The Proposed Actions Excluding the Unleased Blocks Near the Biologically Sensitive Topographic Features

2.3.2.1. Description

Alternative B differs from Alternative A by not offering the blocks that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.3.1.3.1** and **Figure 2-1**). All of the assumptions (including the three other potential mitigating measures) and estimates are the same as for Alternative A. A description of Alternative A is presented in **Chapter 2.3.1.1**.

2.3.3.2. Summary of Impacts

The analyses of impacts summarized in **Chapter 2.3.1.2** and described in detail in **Chapters 4.2.1 and 4.4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapters 4.1.1, 4.1.2, and 4.3**.

The difference between the potential impacts described for Alternative A and those under Alternative B is that under Alternative B no oil and gas activity would take place in the blocks subject to the Topographic Features Stipulation (**Figure 2-1**). The assumption that the levels of activity for Alternative B are essentially the same as those projected for the proposed actions leads to the conclusion that the impacts expected to result from Alternative B would be very similar to those described under the proposed actions (**Chapter 4.2.1**). Therefore, the regional impact levels for all resources, except for the Topographic Features, would be similar to those described under the proposed actions. This alternative, if adopted, would prevent any oil and gas activity whatsoever in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks from oil and gas activities, which otherwise would be conducted within the blocks.

2.3.4. Alternative C — Use of a Nomination and Tract Selection Leasing System

2.3.4.1. Description

In response to the Call for Nominations and Information, the Governor of Louisiana recommended that MMS analyze alternative leasing systems that may increase competition and revenue. A nomination and selection process is currently used by the State of Louisiana for lease sales in its waters. Alternative C — Use of a Nomination and Tract Selection Leasing System was added to this EIS in response to the Governor's recommendation.

Alternative C differs from Alternative A by utilizing a nomination and tract selection leasing system rather than an areawide leasing system. This alternative would offer for lease for each proposed action a maximum of 300 industry-nominated blocks and would offer all blocks that become available for leasing after the industry nomination deadline and before the FNOS is published for that proposed action. The same exclusions described under Alternative A would apply. The number of blocks offered would be about 25 percent of the blocks estimated to be offered under an areawide leasing system (Alternative A), and it is estimated this alternative may result in a 25 percent reduction in the number of blocks leased per proposed action.

From 1954 to 1983, MMS utilized a nomination and tract selection leasing system. Nomination and tract selection means that MMS examines the results of the Call for Nominations and Information for each sale and, based on that and on other information that it has, identifies the blocks it deems prospective and worth offering for lease. These are the selected blocks offered in the sale. From 1983 until the present, MMS conducted lease sales using an areawide leasing system. Areawide leasing means that all available blocks in the area are offered for lease.

When developing this alternative MMS made the following assumptions based on the history of nomination and tract selection and areawide sales. It is estimated 50 percent of newly available blocks and 25 percent of industry-nominated blocks would receive bids. In the WPA, it is estimated there would be approximately 200 newly available blocks. Based on recent leasing patterns, it is assumed the offered blocks would be evenly distributed throughout the 28.6 million ac WPA sale area.

Under nomination and tract selection leasing, it is assumed the best blocks would be made available and leased; therefore, the success rate of the leased blocks would be higher than the success rate under areawide leasing. Although the number of resulting leases may be reduced, the estimated amount of resources under Alternative C would still fall within the range projected to be developed as a result of any one proposed WPA lease sale (0.242-0.423 BBO and 1.644-2.647 Tcf of gas) under Alternative A.

By reducing the number of offered blocks, this alternative may increase bidder competition, thus increasing the number bids and amount received per tract. Under both leasing systems, the number of blocks offered is not the only influence on the number of blocks leased. The number of leased blocks is influenced strongly by newly available blocks, oil prices, resource potential, and cost of development.

2.3.4.2. Summary of Impacts

The analyses of impacts described in detail in **Chapters 4.2.1 and 4.4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related IPF's is included in **Chapters 4.1.1, 4.1.2, and 4.3**.

The assumption that the levels and location of activity for Alternative C are essentially the same as those projected for Alternative A leads to the conclusion that the impacts expected to result from Alternative C would be very similar to those described under the proposed actions (**Chapters 4.2.1 and 4.4**). Therefore, the regional impact levels for all resources would be similar to those described under the proposed actions.

2.3.5. Alternative D — No Action

2.3.5.1. Description

Alternative D is the cancellation of one or more of the proposed WPA lease sales. The opportunity for development of the estimated 0.242-0.423 BBO and 1.644-2.647 Tcf of gas that could have resulted from a proposed lease sale would be precluded or postponed. Any potential environmental impacts resulting from the proposed lease sales would not occur or would be postponed.

2.3.5.2. Summary of Impacts

If Alternative D is selected, all impacts, positive and negative, associated with the proposed lease sales would be eliminated. This alternative would therefore result in no effect on the sensitive resources and activities discussed in **Chapters 4.2.1 and 4.4**. The incremental contribution of the proposed lease sales to cumulative effects would also be foregone, but effects from other activities, including other OCS lease sales, would remain.

Strategies that could provide replacement resources for lost domestic OCS oil and gas production include a combination of energy conservation; onshore domestic oil and gas supplies; alternative energy sources; and imports of oil, natural gas, and liquefied natural gas. Market forces are assumed to be the predominant factor in determining substitutes for OCS oil and gas. Based on this, increased imports of foreign oil are assumed to be the largest replacement source. Much of this imported oil would enter the U.S. through the GOM, thus increasing the probability of tanker spills, which are usually closer to shore and can be larger in volume. This is analyzed in the Draft EIS for the 5-Year Program.

2.4. PROPOSED CENTRAL GULF LEASE SALES 205, 206, 208, 213, 216, AND 222

2.4.1. Alternative A — The Proposed Actions

2.4.1.1. Description

Alternative A would offer for lease all unleased blocks within the CPA for oil and gas operations (**Figure 1-1**), with the following exceptions:

(1) blocks that were previously included within the EPA and that are within 100 mi of the Florida coast;

(2) blocks that were previously included within the EPA and that are under an existing Presidential withdrawal through 2012 as well as subject to annual congressional moratoria;

(3) blocks that are beyond the U.S. Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(4) whole and partial blocks that lie within the 1.4-nmi buffer zone north of the continental shelf boundary between the U.S. and Mexico, for Sales 206, 208, and 213 only.

The CPA sale area encompasses about 58.7 million ac of the CPA's 66.3 million ac. The estimated amount of resources projected to be developed as a result of any one proposed CPA lease sale is 0.776-1.292 BBO and 3.236-5.229 Tcf of gas.

The analyses of impacts summarized below and described in detail in **Chapters 4.2.3 and 4.4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapters 4.1.1, 4.1.2, and 4.3**.

2.4.1.2. Summary of Impacts

Air Quality

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed action activities are expected to be well within the NAAQS. A proposed action would have only a small effect on ozone levels in ozone nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas.

Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications.

Water Quality

Coastal Waters

The primary impacting sources to water quality in coastal waters are point-source and storm water discharges from support facilities, vessel discharges, and nonpoint-source runoff. The impacts to coastal water quality from a proposed action should be minimal as long as all existing regulatory requirements are met.

The ability of coastal waters to assimilate spilled oil is affected by the shallowness of the environment. Large volumes of water are not available to dilute suspended oil droplets and dissolved constituents. Since oil does not mix with water and is usually less dense, most of the oil forms a slick at the surface. Small droplets in the water may adhere to suspended sediment and be removed from the water column. Oil contains toxic aromatic compounds such as benzene, toluene, xylenes, naphthalenes, and polynuclear aromatic hydrocarbons, which are soluble to some extent in water. The effect of these compounds on water quality depends on the circulation in the coastal environment, the composition of the spilled oil, and the length of time the oil is in contact with the water. Oil may also penetrate sand on the beach or be trapped in wetlands, where it can be re-released into the water some time after the initial spill.

Marine Waters

During exploratory activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Impacting discharges during production activities are produced water and supply-vessel discharges. Regulations are in place to limit the levels of contaminants in these discharges. Impacts to marine waters from a proposed action should be minimal as long as regulatory requirements are followed.

Smaller spills (<1,000 bbl) are not expected to significantly impact water quality in marine and coastal waters. Larger spills, however, could impact water quality especially in coastal waters. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary impacts on localized water quality.

Sensitive Coastal Environments

Coastal Barrier Beaches and Associated Dunes

In summary, effects to coastal barrier beaches and associated dunes from pipeline emplacements, navigation channel use and dredging, and construction or continued use of infrastructure in support of a proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 gas processing plants and 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of non-intrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities. Maintenance dredging of barrier inlets and bar channels is expected to occur, which, combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action.

Wetlands

In summary, effects to coastal wetlands from the primary impact-producing activities associated with a proposed action in the CPA are expected to be low. Loss of 0-8 ha (0-20 ac) of wetlands habitat is estimated as a result of 0-2 km (0-1 mi) of new pipelines projected as a result of a proposed action. Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts; a proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. Vessel traffic associated with a proposed action is expected to contribute minimally to the erosion and widening of navigation channels and canals. Overall, impacts from these sources are expected to be low and could be further reduced through mitigation, such as horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitat.

Offshore oil spills resulting from a proposed action are not expected to significantly damage any inland wetlands, however, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in Galveston County and Matagorda County, Texas, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes, Louisiana in the CPA.

Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment and personnel used to clean up a slick over the impacted area may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. Overall, impacts to wetland habitats from an oil spill associated with activities related to a proposed action would be expected to be low and temporary.

Seagrass Communities

Most seagrass communities located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat (discussed in **Chapters 4.3.1.7 and 4.4.2.3**).

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Hence, impacts to submerged vegetation by pipeline installation are projected to be very small and short term.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a navigation channel's area of influence will have already adjusted their bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area or damage to an already stressed area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a CPA proposed action and increased dredging is expected in an area that does not normally support seagrass beds..

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities with the highest probabilities of contact within 10 days would be those located within Matagorda County, Texas, for a proposed action in the WPA and Plaquemines Parish, Louisiana, for a proposed action in the CPA.

Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb to the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Although the probability of their occurrence is low, the greatest threat to inland, seagrass communities would be from an inland spill resulting from a vessel accident or pipeline rupture. Although a resulting slick may cause minor impacts to the bed, equipment and personnel used to clean up a slick over shallow seagrass beds may generate the greatest direct impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Sensitive Offshore Benthic Resources

Live Bottoms (Pinnacle Trend)

Activities resulting from a proposed action in the CPA are not expected to impact adversely the pinnacle trend environment because of implementation of the Live Bottom Stipulation. No community-wide impacts are expected. The inclusion of the Live Bottom Stipulation would minimize the potential for mechanical damage. The impacts of a proposed action are expected to be infrequent because of the few operations in the vicinity of the pinnacles and the small size and dispersed nature of many of the features. Potential impacts from blowouts, pipeline emplacement, mud and cutting discharges, and structure removals would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features. Impacts from accidents involving anchor placement on pinnacles (those actually crushed or subjected to abrasions) could be severe where they occur.

There would be few operations in the vicinity of the pinnacles as a result of a proposed action and these would be restricted by the Live Bottom (Pinnacle Trend) Stipulation. Because of this and the small size and dispersed nature of many of the features, impacts from accidental events as a result of a proposed action are expected to be infrequent. No community-wide impacts are expected. Potential impacts from blowouts would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. Oil spills would not be followed by adverse impacts (e.g., elevated decrease in live cover) because of the depth of the features and dilution of spills (by currents and the quickly rising oil). The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features.

Topographic Features

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

The proposed Topographic Features Stipulations will assist in preventing most of the potential topographic feature communities from blowouts and surface and subsurface oil spills. Recovery from incidences of impacts from blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulations would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Chemosynthetic Deepwater Benthic Communities

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment in the same locations.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience very minor (if any) impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type). There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried by resuspended sediments from a blowout.

Potential accidental impacts from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities located at more than 1,500 ft away from a blowout could experience minor impacts from resuspended sediments.

Nonchemosynthetic Deepwater Benthic Communities

Some impact to soft-bottom benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic infaunal communities occurred, recolonization from populations from neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be relatively rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities. Impacts to other hard-bottom communities are expected to be avoided as a consequence of the application of the existing NTL 2000-G20 for chemosynthetic communities. The same geophysical conditions associated with the potential presence of chemosynthetic communities also results in hard carbonate substrate that is generally avoided.

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of hours to days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities will likely be avoided as a consequence of the application of NTL 2000-G20 and the similar geophysical signatures (hard bottom) indicating the potential presence of chemosynthetic communities.

Accidental events from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities.

Marine Mammals

Small numbers of marine mammals could be killed or injured by a chance collision with a service vessel; however, current MMS requirements and guidelines for vessel operation in the vicinity of protected species should minimize this risk (the proposed Protected Species Lease Stipulation and NTL 2003-G10).

Marine mammal ingestion of industry-generated debris is a concern. Sperm whales may be particularly at risk because of their suspected feeding behavior involving cruising along the bottom with their mouth open. Entanglement in debris could have serious consequences. A sperm whale could suffer diminished feeding and reproductive success, and potential injury, infection and death from entanglement in discarded packing materials or debris. Industry has made good progress in debris management on vessels and offshore structures in the last several years. The debris awareness training, instruction, and placards required by the proposed Protected Species Lease Stipulation and NTL 2003-G11 should greatly minimize the amount of debris that is accidentally lost overboard by offshore personnel.

There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Noise associated with a proposed action, including drilling noise, aircraft, and vessels may affect marine mammals by eliciting a startle response or masking other sounds. However, many of the industry-related sounds are believed to be out of, or on the limits of, marine mammal hearing, and the sounds are also generally temporary. The continued presence of sperm whales in close proximity to some of the deepwater structures in the GOM tends to rule out concerns of permanent displacement from disturbance.

Seismic operations have the potential to harm marine mammals in close proximity to firing airgun arrays. The proposed protected species lease stipulations and the several mitigations, including onboard observers and airgun shut-downs for whales in the exclusion zone, included in NTL 2004-G01 ("Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program") minimize the potential of harm from seismic operations to marine mammals.

Marine mammal death or injury is not expected from explosive structure removal operations. Existing mitigations and those recently developed for structures placed in oceanic waters should continue to minimize adverse effects to marine mammals from these activities.

Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification. Although the scope and magnitude of such effects are not known, direct or indirect effects are not expected to be lethal.

Routine activities related to a proposed action, particularly when mitigated as required by MMS, are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population endemic to the northern GOM.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the GOM. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents, characteristics of spilled oil, spill-response capabilities and timing, and various meteorological and hydrological factors. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in harassment, harm, or mortality to marine mammals occurring in the northern Gulf. Marine mammals made no apparent attempt to avoid spilled oil in some cases (e.g., Smultea and Würsig, 1995); however, marine mammals have been observed apparently detecting and avoiding slicks in other reports (e.g., Geraci and St. Aubin, 1987). Exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick is likely to result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to marine mammals.

Sea Turtles

Routine activities resulting from a proposed action have the potential to harm sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by seismic exploration, helicopter and vessel traffic, platforms, and drillships; vessel collisions; and marine debris generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. Most OCS activities are expected to have sublethal effects.

Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification but there is uncertainty concerning the possible effects. Rapid dilution of the discharges should minimize impact. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas from noise disturbance could cause declines in survival or fecundity, and result in population declines; however, such declines are not expected. The required seismic operation mitigations, particularly clearance of the impact area of sea turtles and marine mammals prior to ramp-up, and the subsequent gradual ramping up of the airguns, should minimize the impact of rapid onset of, and close proximity to, very loud noise. Vessel traffic is a serious threat to sea turtles. Diligence on the part of vessel operators as encouraged by the vessel strike mitigations should minimize vessel/sea turtle collisions. Actual sea turtle impacts from explosive removals in recent years have been small. The updated pre- and post-detonation mitigations should insure that injuries remain extremely rare. Greatly improved handling of waste and trash by industry, along with the annual awareness training required by the marine debris mitigations, is decreasing the plastics in the ocean and minimizing the devastating effects on sea turtles. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the GOM.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to sea turtles occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to sea turtles. Sea turtle hatchling exposure to, fouling by, or consumption of tarballs persisting in the sea following the dispersal of an oil slick by would likely be fatal.

Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

An impact from a proposed action on the Alabama, Choctawhatchee, St. Andrew and Perdido Key beach mice is possible but unlikely. Impact may result from consumption of beach trash and debris. A proposed action would deposit only a small portion of the total debris that would reach the habitat. Efforts undertaken for the removal of marine debris or for beach restoration, such as sand replenishment, may temporarily scare away beach mice, destroy their food resources, or collapse the tops of their burrows.

Given the low probability of a major (≥1,000 bbl) spill occurring, direct impacts of oil spills on beach mice from a proposed action are highly unlikely. Oil-spill response and cleanup activities could have significant impact to the beach mice and their habitat, if not properly regulated.

Coastal and Marine Birds

The majority of effects resulting from a proposed action in the CPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts from pipeline and navigation canals to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigated waterways can contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

Endangered and Threatened Fish

Gulf Sturgeon

Potential impacts on Gulf sturgeon and the designated critical habitat may occur from drilling and produced water discharges, degradation of estuarine and marine water quality by nonpoint runoff from estuarine OCS-related facilities, vessel traffic, explosive removal of structures, and pipeline installation. The dilution and low toxicity of this pollution is expected to result in negligible impact of a proposed action on Gulf sturgeon. Vessel traffic will generally only pose a risk to Gulf sturgeon when leaving and returning to port. Major navigation channels are excluded from critical habitat. The Gulf sturgeon characteristics of bottom-feeding and general avoidance of disturbance make the probability of vessel strike extremely remote. Explosive removal of structures as a result of a proposed action will occur well offshore of Gulf sturgeon critical habitat and the riverine, estuarine, and shallow Gulf habitats where sturgeon are generally located. Environmental permit requirements and recent techniques for locating pipelines will result in very minimal impact to Gulf sturgeon critical habitat if any pipeline is installed nearshore due to a proposed action. Impacts from routine activities resulting from a proposed action in the CPA are expected to have negligible effects on Gulf sturgeon and their designated critical habitat.

The Gulf sturgeon could be impacted by oil spills resulting from a proposed action. Contact with spilled oil could have detrimental physiological effects. However, several factors influence the probability of spilled oil contact with Gulf sturgeon or their critical habitat. The likelihood of spill occurrence and subsequent contact with, or impact to, Gulf sturgeon and/or designated critical habitat is extremely low.

Fish Resources and Essential Fish Habitat

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms, including both pinnacle trend features and topographic features, will experience little or no impact. Live bottoms within No Activity Zones will be completely avoided by all impacting activities. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

Additional hard substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase fish populations. Removal of these structures will eliminate that habitat except when decommissioning results in platforms being used as artificial reef material. This practice is expected to increase over time.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

Law and Hellou (1999) make a clear summary stating, "Accidents and spillages are an inevitable consequence of the worldwide transport of crude oil and refined petroleum products by sea." They also add that the number of major spills occurring each year has decreased since the 1970's. Accidental events resulting from oil and gas development in a proposed action area of the GOM have the potential to cause some detrimental effects on fisheries and commercial fishing practices. A subsurface blowout would have a negligible effect on GOM fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Historically, there have been no oil spills of any size that have had a long-term impact on fishery populations. Any affected commercial fishing activity would recover within 6 months. There is no evidence at this time that commercial fisheries in the GOM have been adversely affected on a regional population level by spills or chronic contamination.

At the expected level of impact, the resultant influence on fish populations and commercial fishing activities from a proposed action would be negligible and indistinguishable from variations due to natural causes. It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Commercial Fishing

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Seismic surveys are not expected to cause long-term or permanent displacement of any listed species from critical habitat/preferred habitat or to result in destruction or adverse modification of critical habitat or essential fish habitat. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations because of natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

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At the expected level of impact, the resultant influence on fish populations and commercial fishing activities from a proposed action would be negligible and indistinguishable from variations due to natural causes. It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Recreational Fishing

The development of oil and gas in the proposed lease sale area could attract additional recreational fishing activity to structures installed on productive leases. Each structure placed in the GOM to produce oil or gas would function as a *de facto* artificial reef, attract sport fish, and improve fishing prospects in the immediate vicinity of platforms. This impact would last for the life of the structure, until the structures are removed from the location and the marine environment. A proposed action would have a beneficial effect on offshore and deep-sea recreational fishing within developed leases accessible to fishermen. These effects would last until the production structures are removed from the marine environment. Short-term space-use conflict could occur during the time that any pipeline is being installed.

The estimated number and size of potential spills associated with a proposed action’s activities are unlikely to decrease recreational fishing activity but may divert the location or timing of a few planned fishing trips. Potential recreational fisheries due to accidental events as a result of a proposed action would be minor to moderate. Based on the sizes of oil spills assumed for a proposed action, only localized and short-term disruption of recreational fishing activity might result (minor impact).

Recreational Resources

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short-term and localized. Should a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill result in a large volume of oil contacting a beach or a large recreational area being contacted by an oil slick, visitation to the area could be reduced by as much as 5-15 percent for as long as one season, but such an event should have no long-term effect on tourism.

Tarballs can lessen the enjoyment of the recreational beaches but should have no long-term effect on the overall use of beaches.

Archaeological Resources

Historic

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the CPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Pearson et al., 2003) resulted in refinement of the areas assessed as having high-potential areas for the location of historic period shipwrecks. An MMS review of the historic high-potential areas for historic shipwrecks is occurring at the time of this writing. The NTL for archaeological resource surveys in the

GOM Region, NTL 2005-G07, mandates a 50-m linespacing for remote-sensing surveys of leases within the areas having high potential for historic shipwrecks in water depths 200 m (656 ft) or less, and 300-m linespacing in water depths greater than 200 m. NTL 2006-G07 identifies those lease blocks that have been designated as having a high potential for containing historic shipwrecks.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the CPA are not expected to impact historic archaeological resources. It is conservatively assumed that about 3-4 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action (**Table 4-9**). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the CPA are not expected to affect historic archaeological resources.

Impact to a historic archaeological resource could occur as a result of an accidental spill. As indicated in **Chapter 4.3.1.7**, it is not very likely that an oil spill will occur and contact coastal historic archaeological sites from accidental events associated with a proposed action. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

Prehistoric

Several impact-producing factors may threaten the prehistoric archaeological resources of the Central Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant and/or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the CPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

Accidental events producing oil spills may threaten the prehistoric archaeological resources of the Gulf Coast. Impacts to prehistoric sites could occur as a result of an oil spill. Should a spill contact an archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

As indicated in **Chapter 4.3.1.7**, it is not very likely for an oil spill to occur and contact coastal and barrier island prehistoric sites as a result of a proposed action. The proposed actions are not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

Human Resources and Land Use

Land Use and Coastal Infrastructure

A proposed action in the CPA would not require additional coastal infrastructure, with the exception of possibly one new gas processing facility, and would not alter the current land use of the analysis area.

Demographics

Activities relating to a proposed CPA lease sale are expected to affect minimally the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one EIA. Baseline patterns and distributions of these factors, as described in **Chapter 3.3.5.4**, are expected to approximately maintain the same level. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring clean up of any oil or chemicals spilled.

Economic Factors

Should a proposed CPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, Alabama, and Florida EIA's. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force for reasons discussed above. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

Environmental Justice

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a proposed action in the CPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on these populations.

Lafourche Parish will experience the most concentrated effects of a proposed action; however, because the Parish is not heavily low-income or minority, because the Houma are not residentially segregated, and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups will not be differentially affected. In general, the effects in Lafourche Parish are expected to be mostly economic and positive. A proposed action would help to maintain ongoing levels of activity rather than expand them. Future changes in activity levels will most likely be caused by fluctuations in oil prices and imports, and not by activities related to a proposed action. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

Considering the low likelihood of an oil spill and the heterogeneous population distribution along the GOM region, accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

2.4.1.3. Mitigating Measures

2.4.1.3.1. Topographic Features Stipulation

The topographic features located in the CPA provide habitat for coral reef community organisms (**Chapter 3.2.2.1.2**). These communities could be severely and adversely impacted by oil and gas activities resulting from the proposed actions if such activities took place on or near these communities without the Topographic Features Stipulation and if such activities were not mitigated. The DOI has recognized this problem for some years, and since 1973 stipulations have been made a part of leases on or near these biotic communities so that impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation would not prevent the recovery of oil and gas resources but would serve to protect valuable and sensitive biological resources.

The Topographic Features Stipulation was formulated based on consultation with various Federal agencies and comments solicited from the States, industry, environmental organizations, and academic representatives. The stipulation is based on years of scientific information collected since the inception of the stipulation. This information includes various Bureau of Land Management/MMS-funded studies on the topographic highs in the CPA; numerous stipulation-imposed, industry-funded monitoring reports; and the National Research Council (NRC) report entitled *Drilling Discharges in the Marine Environment* (1983). The location and lease status of the blocks affected by the Topographic Features Stipulation are shown on **Figure 2-1**.

The requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer confines the effluent to a level deeper than that of the living reef of a high-relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high-relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NRC, 1983).

(b) The biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef-building activity (Rezak and Bright, 1981; Rezak et al., 1983 and 1985).

The stipulation establishes No Activity Zones at the topographic features. A zone is defined by the 85-m bathymetric contour (isobath) since, generally, the biota shallower than 85 m are more typical of the Caribbean reef biota, while the biota deeper than 85 m are similar to soft-bottom organisms found throughout the Gulf. Where a topographic feature is in water depths less than 85 m, the deepest "closing" isobath defines the No Activity Zone for that area. Within the No Activity Zones, no operations, anchoring, or structures are allowed. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted.

The stipulation requires that all effluents within 1,000 m of banks containing an antipatharian-transitional zone be shunted to within 10 m of the seafloor. Banks containing the more sensitive and productive algal-sponge zone require a shunt zone extending 1 nautical mile (nmi) and an additional 3-nmi shunt zone for development only.

The stipulation reads as follows:

Topographic Features Stipulation

(a) No activity including structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the leases on banks as listed above.

(b) Operations within "1,000-Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

(c) Operations within "1-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom. (Where there is a "1-Mile Zone" designated, the "1,000-Meter Zone" in paragraph (b) is not designated.)

(d) Operations within "3-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 m, from the bottom.

The banks and corresponding blocks to which this stipulation may be applied in the CPA are as follows:

Bank Name	Isobath (m)	Bank Name	Isobath (m)
McGrail Bank	85	Jakkula Bank	85
Bouma Bank	85	Sweet Bank[1]	85
Rezak Bank	85	Bright Bank	85
Sidner Bank	85	Geyer Bank	85
Sackett Bank[2]	85	Elvers Bank	85
Ewing Bank	85	Alderdice Bank	80
Diaphus Bank[2]	85	Fishnet Bank[2]	76
Parker Bank	85	Sonnier Bank	55

[1] Only paragraph (a) of the stipulation applies.
[2] Only paragraphs (a) and (b) of the stipulation apply.
[3] CPA bank with a portion of its "3-Mile Zone" in the WPA.

Effectiveness of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from adverse effects due to routine oil and gas activities. Such effects include physical damage from anchoring and rig emplacement and potential toxic and smothering effects from muds and cuttings discharges. The Topographic Features Stipulation has been used on leases since 1973, and this experience shows conclusively that the stipulation effectively prevents damage to the biota of these banks from routine oil and gas activities. Anchoring related to oil and gas activities on the sensitive portions of the topographic features has been prevented. Monitoring studies have demonstrated that the shunting requirements of the stipulations are effective in preventing the muds and cuttings from impacting the biota of the banks. The stipulation, if adopted for the proposed actions, will continue to protect the biota of the banks, specifically as discussed below.

Mechanical damage resulting from oil and gas operations is probably the single most serious impact to benthic habitat. Complying with the No Activity Zone designation of the Topographic Features Stipulation should completely eliminate this threat to the sensitive biota of WPA topographic features from activities resulting from the proposed actions. The sensitive biota within the zones provided for in the Topographic Features Stipulation will thus be protected.

Several other impact-producing factors may threaten communities associated with topographic features. Vessel anchoring and structure emplacement result in physical disturbance of benthic habitat and are the most likely activities to cause permanent or long-lasting impacts to sensitive offshore habitats. Recovery from damage caused by such activities may take 10 or more years (depending on the maturity of the impacted community). Operational discharges (drilling muds and cuttings, produced waters) may impact the biota of the banks due to turbidity and sedimentation, resulting in death to benthic organisms in large areas. Recovery from such damage may take 10 or more years (depending on the maturity of the impacted community). Blowouts may cause similar damage to benthic biota by resuspending sediments, causing turbidity and sedimentation, which could ultimately have a lethal impact on benthic organisms. Recovery from such damage may take up to 10 years (depending on the maturity of the impacted community). Oil spills will cause damage to benthic organisms if the oil contacts the organisms; such contact is unlikely except from spills from blowouts. There have been few blowouts in the GOM.

Structure removal using explosives can result in water turbidity, redeposition of sediments, and explosive shock-wave impacts. Recovery from such damage could take more than 10 years (depending on the maturity of the impacted community). The above activities, especially bottom-disturbing activities, have the greatest potential to severely impact the biota of topographic features. Those activities having the greatest impacts are also those most likely to occur. The proposed actions, without benefit of the Topographic Features Stipulation or comparable mitigation, are expected to have a severe impact on the sensitive offshore habitats of the topographic features.

The stipulation provides different levels of protection for banks in different categories as defined by Rezak and Bright (1981). The categories and their definitions are as follows:

Category A:	zone of major reef-building activity; maximum environmental protection recommended;
Category B:	zone of minor reef-building activity; environmental protection recommended;
Category C:	zone of negligible reef-building activity, but crustose algae present; environmental protection recommended; and
Category D:	zone of no reef-building or crustose algae; additional protection not necessary.

The stipulation requires that all effluents within 1,000 m of Sackett, Fishnet, and Diaphus Banks, categorized by Rezak and Bright (1981) as Category C banks, be shunted into the nepheloid layer; the potentially harmful materials in drilling muds will be trapped in the bottom boundary layer and will not move up the banks where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m from the bank is not expected to impact the biota.

The stipulation protects the remaining banks (Category A and B banks) with even greater restrictions. Surface discharge will not be allowed within 1 nmi of these more sensitive banks. Surface discharges outside of 1 nmi are not expected to impact the biota of the banks, as adverse effects from surface discharge are limited to 1,000 m. However, it is possible that, when multiple wells are drilled from a single platform (surface location), typical during development operations, extremely small amounts of muds discharged more than 1 nmi from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged during development drilling, the stipulation imposes a 3-Mile Zone within which shunting of development well effluent is required.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from the proposals, while allowing the development of nearby oil and gas resources. The stipulation will not protect the banks from the adverse effects of an accident such as a large blowout on a nearby oil or gas operation.

2.4.1.3.2. Live Bottom (Pinnacle Trend) Stipulation

The Live Bottom (Pinnacle Trend) Stipulation covers the pinnacle trend area of the CPA (**Figure 2-1**). A small portion of the northeastern CPA sale area is characterized by a pinnacle trend, which is classified as a live bottom under the stipulation. The pinnacles are a series of topographic irregularities with variable biotal coverage, which provide structural habitat for a variety of pelagic fish. The pinnacles in the region could be impacted from physical damage of unrestricted oil and gas activities, as noted in **Chapter 4.2.3.1.4.1.1**. The Live Bottom (Pinnacle Trend) Stipulation is intended to protect the pinnacle trend and the associated hard-bottom communities from damage and, at the same time, provide for recovery of potential oil and gas resources. The stipulation reads as follows:

Live Bottom (Pinnacle Trend) Stipulation

For the purpose of this stipulation, "live bottom areas" are defined as seagrass communities; or those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna.

Prior to any drilling activities or the construction or placement of any structure for exploration or development on this lease, including, but not limited to, anchoring, well drilling, and pipeline and platform placement, the lessee will submit to the Regional Director (RD) a live bottom survey report containing a bathymetry map prepared utilizing remote sensing techniques. The bathymetry map shall be prepared for the purpose of determining the presence or absence of live bottoms which could be impacted by the proposed activity. This map shall encompass such an area of the seafloor where surface disturbing activities, including anchoring, may occur.

If it is determined that the live bottoms might be adversely impacted by the proposed activity, the RD will require the lessee to undertake any measure deemed economically, environmentally, and technically feasible to protect the pinnacle area. These measures may include, but are not limited to, the following:

a. the relocation of operations; and

b. the monitoring to assess the impact of the activity on the live bottoms.

Effectiveness of the Lease Stipulation

Through detection and avoidance, this stipulation minimizes the likelihood of mechanical damage from OCS activities associated with rig and anchor emplacement to the sessile and pelagic communities associated with the crest and flanks of such features. Since this area is subject to heavy natural sedimentation, this stipulation does not include any specific measures to protect the pinnacles from the discharge of effluents.

The sessile and pelagic communities associated with the crest and flanks of the pinnacle and hard-bottom features could be adversely impacted by oil and gas activities resulting from the proposed actions if such activities took place on or near these communities without the Live Bottom (Pinnacle Trend) Stipulation. For many years, this stipulation has been made a part of leases on blocks in the CPA on or near these biotic communities so that impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation does not prevent the recovery of oil and gas resources; however, it does serve to protect valuable and sensitive biological resources.

Activities resulting from the proposed actions, particularly anchor damage to localized pinnacle areas, are expected to cause substantial damage to portions of the pinnacle trend environment because these activities are potentially destructive to the biological communities and could damage one or several individual pinnacles. The most potentially damaging of these are the impacts associated with mechanical damages that may result from anchors. However, the action is judged to be infrequent because of the limited operations in the vicinity of the pinnacles and the small size of many of the features. Minor impact is expected from large oil spills, blowouts, pipeline emplacement, muds and cuttings discharges, and structure removals. The frequency of impacts to the pinnacles is rare, and the severity is judged to be slight because of the widespread nature of the features within the pinnacle trend area. The proposed actions, without the benefit of the Live Bottom (Pinnacle Trend) Stipulation, could have an adverse impact on the pinnacle region, but such impact is expected to be of a localized nature. Impact from mechanical damage including anchors could potentially be long term if the physical integrity of the pinnacles themselves became altered.

The pinnacle trend occurs as patchy regions within the general area of the eastern portion of the CPA (Ludwick and Walton, 1957; Vittor and Associates, Inc., 1985; Brooks and Giammona, 1990). The pinnacle trend also extends into the EPA. The stipulation would require the operators to locate the individual pinnacles and associated communities that may be present in the block. The stipulation requires that a survey be done to encompass the potential area of proposed surface disturbance and that a bathymetry map depicting any pinnacles in the vicinity be prepared from the survey. (Since it is the pinnacles themselves and the habitat they provide for various species that are sensitive to impacts from oil and gas activities, photodocumentation of the identified pinnacles is not warranted.) The MMS GOM Regional Director, through consultation with FWS, could then decide if pinnacles in the trend would be potentially impacted and, if so, require appropriate mitigative measures.

By identifying the individual pinnacles present at the activity site, the lessee would be directed to avoid placement of the drilling rig and anchors on the sensitive areas. Thus, mechanical damage to the pinnacles is eliminated when measures required by the stipulation are imposed. The stipulation does not address the discharge of effluents near the pinnacles because the pinnacle trend is subjected to heavy natural sedimentation and is at considerable depths. The rapid dilution of drill cuttings and muds will minimize the potential of significant concentration of effluents on the pinnacles.

2.4.1.3.3. Military Areas Stipulation

A standard military warning areas stipulation has been applied to all blocks leased in military areas in the GOM since 1977. **Figure 2-2** shows the military warning areas in the GOM. This stipulation would be a part of any lease resulting from the proposed actions. The stipulation reads as follows:

Military Areas Stipulation

(a) Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the Outer Continental Shelf (OCS), to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the OCS, if such injury or damage to such person or property occurs by reason of the activities of any agency of the U.S. Government, its contractors or subcontractors, or any of its officers, agents or employees, being conducted as a part of, or in connection with, the programs and activities of the command headquarters.

Notwithstanding any limitation of the lessee's liability in section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the U.S., its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the U.S. against all claims for loss, damage, or injury sustained by the lessee, or to indemnify and save harmless the U.S. against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the U.S., its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

(b) Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of its agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters to the degree necessary to prevent damage to, or unacceptable interference with, Department of Defense flight, testing, or operational activities, conducted within individual designated warning areas. Necessary monitoring control, and coordination with the lessee, its agents, employees, invitees, independent contractors or subcontractors, will be effected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, independent contractors or subcontractors and onshore facilities.

(c) Operational

The lessee, when operating or causing to be operated on its behalf, boat, ship, or aircraft traffic into the individual designated warning areas shall enter into an agreement with the commander of the individual command headquarters listed in the following list, upon utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats, ships, and aircraft operating into the warning areas at all times.

Effectiveness of the Lease Stipulation

The hold harmless section of the military stipulation serves to protect the U.S. Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and its agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and its agents to reduce and curtail the use of radio, CB, or other equipment emitting electromagnetic energy within some areas. This serves to reduce the impact of oil and gas activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of oil and gas activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers that will avoid the areas where oil and gas activities are taking place or to schedule around these activities. Prior notification helps reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

This stipulation reduces potential impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The reduction in potential impacts resulting from this stipulation makes multiple-use conflicts most unlikely. Without the stipulation, some potential conflict is likely. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and oil and gas activities.

2.4.1.3.4. Evacuation Stipulation

This stipulation would be a part of any lease in the easternmost portion of the CPA sale area resulting from the proposed actions, i.e., Sales 205, 206, 208, 213, 216, and 222. An evacuation stipulation has been applied to all blocks leased in this area since 2001. The stipulation reads as follows:

Evacuation Stipulation

(a) The lessee, recognizing that oil and gas resource exploration, exploitation, development, production, abandonment, and site cleanup operations on the leased area of submerged lands may occasionally interfere with tactical military operations, hereby recognizes and agrees that the United States reserves and has the right to temporarily suspend operations and/or require evacuation on this lease in the interest of national security. Such suspensions are considered unlikely in this area. Every effort will be made by the appropriate military agency to provide as much advance notice as possible of the need to suspend operations and/or evacuate. Advance notice of fourteen (14) days shall normally be given before requiring a suspension or evacuation, but in no event will the notice be less than four (4) days. Temporary suspension of operations may include the evacuation of personnel, and appropriate sheltering of personnel not evacuated. Appropriate shelter shall mean the protection of all lessee personnel for the entire duration of any Department of Defense activity from flying or falling objects or substances and will be implemented by a written order from the MMS Regional Supervisor for Field Operations (RS-FO), after consultation with the appropriate command headquarters or other appropriate military agency, or higher authority. The appropriate command headquarters, military agency or higher authority shall provide information to allow the lessee to assess the degree of risk to, and provide sufficient protection for, lessee's personnel and property. Such suspensions or evacuations for national security reasons will not normally exceed seventy-two (72) hours; however, any such suspension may be extended by order of the RS-FO. During such periods, equipment may remain in place, but all production, if any, shall cease for the duration of the temporary suspension if so directed by the RS-FO. Upon cessation of any temporary suspension, the RS-FO will immediately notify the lessee such suspension has terminated and operations on the leased area can resume.

(b) The lessee shall inform the MMS of the persons/offices to be notified to implement the terms of this stipulation.

(c) The lessee is encouraged to establish and maintain early contact and coordination with the appropriate command headquarters, in order to avoid or minimize the effects of conflicts with potentially hazardous military operations.

(d) The lessee shall not be entitled to reimbursement for any costs or expenses associated with the suspension of operations or activities or the evacuation of property or personnel in fulfillment of the military mission in accordance with subsections (a) through (c) above.

(e) Notwithstanding subsection (d), the lessee reserves the right to seek reimbursement from appropriate parties for the suspension of operations or activities or the evacuation of property or personnel associated with conflicting commercial operations.

Effectiveness of the Lease Stipulation

This stipulation would provide for evacuation of personnel and shut-in of operations during any events conducted by the military that could pose a danger to ongoing oil and gas operations. It is expected that the invocation of these evacuation requirements will be extremely rare.

It is expected that these measures will serve to eliminate dangerous conflicts between oil and gas operations and military operations. Continued close coordination between MMS and the military may result in improvements in the wording and implementation of these stipulations.

2.4.1.3.5. Coordination Stipulation

This stipulation would be a part of any lease in the easternmost portion of the CPA sale area resulting from the proposed actions, i.e., Sales 205, 206, 208, 213, 216, and 222. A coordination stipulation has been applied to all blocks leased in this area since 2001. The stipulation reads as follows:

Coordination Stipulation

(a) The placement, location, and planned periods of operation of surface structures on this lease during the exploration stage are subject to approval by the MMS Regional Director (RD) after the review of an operator's EP. Prior to approval of the EP, the lessee shall consult with the appropriate command headquarters regarding the location, density, and the planned periods of operation of such structures, and to maximize exploration while minimizing conflicts with Department of Defense activities. When determined necessary by the appropriate command headquarters, the lessee will enter a formal Operating Agreement with such command headquarters, that delineates the specific requirements and operating param for the lessee's Final activities in accordance with the military stipulation clauses contained herein. If it is determined that the Final operations will result in interference with scheduled military missions in such a manner as to possibly jeopardize the national defense or to pose unacceptable risks to life and property, then the RD may approve the EP with conditions, disapprove it, or require modification in accordance with 30 CFR 250. The RD will notify the lessee in writing of the conditions associated with plan approval, or the reason(s) for disapproval or required modifications. Moreover, if there is a serious threat of harm or damage to life or property, or if it is in the interest of national security or defense, pending or approved operations may be suspended in accordance with 30 CFR 250. Such a suspension will extend the term of a lease by an amount equal to the length of the suspension, except as provided in 30 CFR 250.169(b). The RD will attempt to minimize such suspensions within the confine of related military requirements. It is recognized that the issuance of a lease conveys the right to the lessee as provided in section 8(b)(4) of the Outer Continental Shelf Lands Act to engage in exploration, development, and production activities conditioned upon other statutory and regulatory requirements.

(b) The lessee is encouraged to establish and maintain early contact and coordination with the appropriate command headquarters, in order to avoid or minimize the effects of conflicts with potentially hazardous military operations.

(c) If national security interests are likely to be in continuing conflict with an existing operating agreement, the RD will direct the lessee to modify any existing operating agreement or to enter into a new operating agreement to implement measures to avoid or minimize the identified potential conflicts, subject to the terms and conditions and obligations of the legal requirements of the lease.

Effectiveness of the Lease Stipulation

This stipulation would provide for review of pending oil and gas operations by military authorities and could result in delaying oil and gas operations if military activities have been scheduled in the area that may put the oil and gas operations and personnel at risk.

2.4.1.3.6. Blocks South of Baldwin County, Alabama, Stipulation

This stipulation will be included only on leases on blocks south of and within 15 mi of Baldwin County, Alabama. The stipulation reads as follows:

Blocks South of Baldwin County, Alabama, Stipulation

In order to minimize visual impacts from development operations on this block, you will contact lessees and operators of leases in the vicinity prior to submitting a Development Operations Coordination Document (DOCD) to determine if existing or planned surface production structures can be shared. If feasible, your DOCD should reflect the results of any resulting sharing agreement, propose the use of subsea technologies, or propose another development scenario that does not involve new surface structures.

If you cannot formulate a feasible development scenario that does not call for new surface structure(s), your DOCD should ensure that they are the minimum necessary for the proper development of the block and that they will be constructed and placed, using orientation, camouflage, or other design measures, to limit their visibility from shore.

The MMS will review and make decisions on your DOCD in accordance with applicable Federal regulations and MMS policies, and in consultation with the State of Alabama (Geological Survey/Oil and Gas Board).

Effectiveness of the Lease Stipulation

For several years, the Governor of Alabama has continually indicated opposition to new leasing south and within 15 mi of Baldwin County but has requested that, if the area is offered for lease, a lease stipulation to reduce the potential for visual impacts should be applied to all new leases in this area. Prior to the decision in 1999 on the Final Notice of Sale for Sale 172, the MMS, GOM OCS Regional Director, in consultation with the Geological Survey of Alabama/State Oil and Gas Board, developed a lease stipulation to be applied to any new leases within the 15-mi area to mitigate potential visual impacts. The stipulation specifies requirements for consultation that lessees must follow when developing plans for fixed structures. The stipulation has been continually adopted in annual Central GOM lease sales since 1999. It has been considered satisfactorily responsive to the concern of the Governor of Alabama and is proposed at this time for adoption in each of the future Central GOM lease sales in the current 5-Year Program, i.e., Sales 185, 190, 194, 198, and 201.

2.4.1.3.7. Protected Species Stipulation

A protected species stipulation has been applied to all blocks leased in the GOM since 2001. This stipulation would be a part of any lease resulting from the proposed actions, i.e., Sales 205, 206, 208, 213, 216, and 222. The stipulation reads as follows:

Protected Species Stipulation

To reduce the potential taking of federally protected species (e.g., sea turtles, marine mammals, Gulf sturgeon, and other listed species):

(a) The MMS will condition all permits issued to lessees and their operators to require them to collect and remove flotsam resulting from activities related to exploration, development, and production of this lease.

(b) The MMS will condition all permits issued to lessees and their operators to require them to post signs in prominent places on all vessels and platforms used as a result of activities related to exploration, development, and production of this lease detailing the reasons (legal and ecological) why release of debris must be eliminated.

(c) The MMS will require that vessel operators and crews watch for marine mammals and sea turtles, reduce vessel speed to 10 knots or less when assemblages of cetaceans are observed and maintain a distance of 90 m or greater from whales, and a distance of 45 m or greater from small cetaceans and sea turtles.

(d) The MMS will require that all seismic surveys employ mandatory mitigation measures including the use of a 500-meter "exclusion zone" based upon the appropriate water depth, ramp-up and shut-down procedures, visual monitoring and reporting. Seismic operations must immediately cease when certain marine mammals are detected within the 500-meter exclusion zone. Ramp-up procedures and seismic surveys may be initiated only during daylight unless alternate monitoring methods approved by MMS are used.

(e) The MMS will require lessees and operators to instruct offshore personnel to immediately report all sightings and locations of injured or dead protected species (marine mammals and sea turtles) to the appropriate stranding network. If oil and gas industry activity is responsible for the injured or dead animals (e.g. because of a vessel strike), the responsible parties should remain available to assist the stranding network. If the injury or death was caused by a collision with your vessel, you must notify MMS within 24 hours of the strike.

(f) The MMS will require oil spill contingency planning to identify important habitats, including designated critical habitat, used by listed species (e.g. sea turtle nesting beaches, piping plover critical habitat), and require the strategic placement of spill cleanup equipment to be used only by personnel trained in less-intrusive cleanup techniques on beach and bay shores.

Lessees and operators will be instructed how to implement these mitigation measures in NTL's.

Effectiveness of the Lease Stipulation

This stipulation was developed in consultation with NOAA Fisheries Service and FWS, and is designed to minimize or avoid potential adverse impacts to federally protected species.

2.4.2. Alternative B — The Proposed Actions Excluding the Unleased Blocks Near the Biologically Sensitive Topographic Features

2.4.2.1. Description

Alternative B differs from Alternative A by not offering the blocks that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.4.1.3.1** and **Figure 2-1)**. All of the assumptions (including the six other potential mitigating measures) and estimates are the same as for Alternative A. A description of Alternative A is presented in **Chapter 2.4.1.1**.

2.4.2.2. Summary of Impacts

The analyses of impacts summarized in **Chapter 2.4.1.2** and described in detail in **Chapters 4.2.2 and 4.4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapters 4.1.1, 4.1.2, and 4.3**.

The difference between the potential impacts described for Alternative A and those under Alternative B is that under Alternative B no oil and gas activity would take place in the blocks subject to the Topographic Features Stipulation (**Figure 2-1**). The assumption that the levels of activity for Alternative B are essentially the same as those projected for the proposed actions leads to the conclusion that the impacts expected to result from Alternative B would be very similar to those described under the proposed actions (**Chapter 4.2.2**). Therefore, the regional impact levels for all resources, except for the topographic features, would be similar to those described under the proposed actions. This alternative, if adopted, would prevent any oil and gas activity whatsoever in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks from oil and gas activities, which otherwise would be conducted within the blocks.

2.4.3. Alternative C — The Proposed Actions Excluding the Unleased Blocks within 15 Miles of the Baldwin County, Alabama, Coast

2.4.3.1. Description

Alternative C differs from Alternative A by not offering any unleased blocks within 15 mi of the Baldwin County, Alabama, coast. All the assumptions (including potential mitigating measures) and estimates are the same those under Alternative A (**Chapters 2.4.1.3 and 4.1.1**). A description of Alternative A is presented in **Chapter 2.4.1.1**. The coastal region adjacent to the area considered under Alternative C is designated Economic Impact Area (EIA) AL-1 (**Figure 4-2**).

2.4.3.2. Summary of Impacts

The analyses of impacts summarized **Chapter 2.4.1.2** and described in detail in **Chapters 4.2.2 and 4.4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapters 4.1.1, 4.1.2, and 4.3**.

The difference between the potential impacts described for Alternative A and those under Alternative C is that under Alternative C no oil and gas activity would take place in blocks within 15 mi of the Baldwin County coast (**Figure 2-1**). The assumption that the levels of activity for Alternative C are essentially the same as those projected for the proposed actions leads to the conclusion that the impacts expected to result from Alternative C would be very similar to those described under the proposed actions

(**Chapter 4.2.2**). Therefore, the regional impact levels for all resources, except recreational beaches, would be similar to those described under the proposed actions. This alternative, if adopted, would reduce the potential aesthetic impacts to recreational beaches along the Baldwin County coast.

2.4.4. Alternative D — Use of a Nomination and Tract Selection Leasing System

2.4.4.1. Description

In response to the Call for Nominations and Information, the Governor of Louisiana recommended that MMS analyze alternative leasing systems that may increase competition and revenue. A nomination and selection process is currently used by the State of Louisiana for lease sales in its waters. Alternative D — Use of a Nomination and Tract Selection Leasing System was added to this EIS in response to the Governor's recommendation.

Alternative D differs from Alternative A by utilizing a nomination and tract selection leasing system rather than an areawide leasing system. This alternative would offer for lease for each proposed action a maximum of 1,000 industry-nominated blocks, and offer all blocks that become available for leasing after the industry nomination deadline and before the FNOS is published for that proposed action. The same exclusions described under Alternative A would apply. The number of blocks offered would be about 25 percent of the blocks estimated to be offered under an areawide leasing system (Alternative A), and it is estimated this alternative may result in a 25 percent reduction in the number of blocks leased per proposed action.

From 1954 to 1983, MMS used a nomination and tract selection leasing system. Nomination and tract selection means that MMS examines the results of the Call for Nominations and Information for each sale and, based on that and on other information that it has, identifies the blocks it deems prospective and worth offering for lease. These are the selected blocks offered in the sale. From 1983 until the present, MMS conducted lease sales using an areawide leasing system. Areawide leasing means that all available blocks in the area are offered for lease.

When developing this alternative MMS made the following assumptions based on the history of nomination and tract selection and areawide sales. It is estimated 50 percent of newly available blocks and 25 percent of industry nominated blocks would receive bids. In the CPA, it is estimated there would be approximately 400 newly available blocks. Based on recent leasing patterns, it is assumed the offered blocks would be evenly distributed throughout the 58.7 million ac CPA sale area.

Under nomination and tract selection leasing, it is assumed the best blocks would be made available and leased; therefore, the success rate of the leased blocks would be higher than the success rate under areawide leasing. Although the number of resulting leases may be reduced, the estimated amount of resources under Alternative D would still fall within the range projected to be developed as a result of any one proposed CPA lease sale (0.776-1.292 BBO and 3.236-5.229 Tcf of gas) under Alternative A.

By reducing the number of offered blocks, this alternative may increase bidder competition, thus increasing the number of bids and amount received per tract. Under both leasing systems, the number of blocks offered is not the only influence on the number of blocks leased. The number of leased blocks is influenced strongly by newly available blocks, oil prices, resource potential, and cost of development.

2.4.4.2. Summary of Impacts

The analyses of impacts described in detail in **Chapters 4.2.2 and 4.4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact producing factors is included in **Chapters 4.1.1, 4.1.2, and 4.3**.

The assumption that the levels and location of activity for Alternative D are essentially the same as those projected for Alternative A leads to the conclusion that the impacts expected to result from Alternative D would be very similar to those described under the proposed actions (**Chapters 4.2.2 and 4.4**). Therefore, the regional impact levels for all resources would be similar to those described under the proposed actions.

2.4.5. Alternative E — No Action

2.4.5.1. Description

Alternative E is the cancellation of one or more of the proposed CPA lease sales. The opportunity for development of the estimated 0.776-1.292 BBO and 3.236-5.229 Tcf of gas that could have resulted from a proposed lease sale would be precluded or postponed. Any potential environmental impacts resulting from the proposed lease sales would not occur or would be postponed.

2.4.5.2. Summary of Impacts

If Alternative E is selected, all impacts, positive and negative, associated with the proposed lease sales would be eliminated. This alternative would therefore result in no effect on the sensitive resources and activities discussed in **Chapters 4.2.2 and 4.4**. The incremental contribution of the proposed lease sales to cumulative effects would also be foregone, but effects from other activities, including other OCS lease sales, would remain.

Strategies that could provide replacement resources for lost domestic OCS oil and gas production include a combination of energy conservation; onshore domestic oil and gas supplies; alternative energy sources; and imports of oil, natural gas, and liquefied natural gas. Market forces are assumed to be the predominant factor in determining substitutes for OCS oil and gas. Based on this, increased imports of foreign oil are assumed to be the largest replacement source. Much of this imported oil would enter the U.S. through the GOM, thus increasing the probability of tanker spills, which are usually closer to shore and can be larger in volume. This is analyzed in the Draft EIS for the 5-Year Program.

CHAPTER 3

DESCRIPTION OF THE AFFECTED ENVIRONMENT

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

Chapter 3 describes the environment that would potentially be affected by the proposed actions or the alternatives. Baseline data are described for the physical environment (**Chapter 3.1**), biological resources (**Chapter 3.2**), and socioeconomic activities (**Chapter 3.3**) analyzed in this EIS. This chapter also describes existing offshore and coastal infrastructure (**Chapters 3.3.5.7 and 3.3.5.8**), which supports OCS oil and gas activities. Baseline data are considered in the assessment of impacts from the proposed actions to these resources and the environment (**Chapter 4**).

During the past few years, the Gulf Coast States and GOM oil and gas activities have been impacted by several major hurricanes. **Appendix A.3** provides detailed information on Hurricanes Lili (2002), Ivan (2004), Katrina (2005), and Rita (2005), which are discussed in **Chapter 3 and Chapter 4**. The description of the affected environment below includes impacts from these storms on the physical environmental, biological environment, and socioeconomic activities (**Chapters 3.1, 3.2, and 3.3**) and OCS-related infrastructure (**Chapters 3.3.5.7 and 3.3.5.8**).

3.1. PHYSICAL ENVIRONMENT

3.1.1. Air Quality

The Clean Air Act established the National Ambient Air Quality Standards (NAAQS); the primary standards are to protect public health and the secondary standards are to protect public welfare. The current NAAQS are shown in **Table 3-1**. The Clean Air Act Amendments of 1990 established classification designations based on regional monitored levels of ambient air quality. These designations impose mandated timetables and other requirements necessary for attaining and maintaining healthful air quality in the U.S. based on the seriousness of the regional air quality problem.

When measured concentrations of regulated pollutants exceed standards established by the NAAQS, an area may be designated as a nonattainment area for a regulated pollutant. The number of exceedances and the concentrations determine the nonattainment classification of an area. There are five classifications of nonattainment status: marginal, moderate, serious, severe, and extreme (Clean Air Act Amendments, 1990).

The Federal OCS waters attainment status is unclassified. The OCS areas are not classified because there is no provision for any classification in the Clean Air Act for waters outside of the boundaries of State waters. Only areas within State boundaries are to be classified either attainment, nonattainment, or unclassifiable. Operations west of 87.5° W. longitude fall under MMS jurisdiction for enforcement of the Clean Air Act. The OCS waters east of 87.5° W. longitude are under the jurisdiction of USEPA. **Figure 3-1** presents the air quality status in the Gulf Coast as of September 2005. All air-quality nonattainment areas reported in **Figure 3-1** are for ozone nonattainment. As of August 2005, the new 8-hr ozone standard NAAQS of 0.085 ppm has been fully implemented.

Gulf Coast States attainment status for criteria pollutants (CO, SO_2, NO_2, PM and O_3) is as follows:

Texas is in attainment for the pollutants SO_2 and NO_2. The following Texas coastal counties are classified as nonattainment for ozone: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Jefferson, Hardin, Montgomery, Orange, and Walter.

Louisiana emissions are presented in the *2002 Louisiana Environmental Inventory Report* (Louisiana Dept. of Environmental Quality, 2004). Louisiana is in attainment for CO, SO_2, NO_2, and PM, and nonattainment for O_3. Five parishes (Ascension, East Baton Rouge, Iberville, Livingston, and West Baton Rouge) in the Baton Rouge area are nonattainment for O_3. In the last two decades, O_3 in this nonattainment area has steadily declined as a result of deliberate actions to reduce ozone precursor emissions, as well as research and regulatory work done to understand the causes of ozone formation in the area. The average number of ozone exceedances in the area has declined, as has the number of air pollution monitors recording exceedances.

Air quality data for 2005 from Mississippi, Alabama, and Florida show all states in attainment of the NAAQS for all criteria pollutants (USEPA, 2005a).

Prevention of Significant Deterioration (PSD) Class I air quality areas, designated under the Clean Air Act, are afforded the greatest degree of air quality protection and are protected by stringent air quality standards that allow for very little deterioration of their air quality. The PSD maximum allowable pollutant increase for Class I areas are as follows: 2.5 $\mu g/m^3$ annual increment for NO_2; 25 $\mu g/m^3$ 3-hr increment, 5 $\mu g/m^3$ 24-hr increment, and 2 $\mu g/m^3$ annual increment for SO_2; and 8 $\mu g/m^3$ 24-hr increment and 4 $\mu g/m^3$ annual increment for PM_{10}. The CPA includes the Breton National Wildlife Refuge and National Wilderness Area (BNWA) south of Mississippi, which is designated as a PSD Class I area. The U.S. Fish and Wildlife Service (FWS) has responsibility for protecting wildlife, vegetation, visibility, and other sensitive resources called air-quality-related values in this area. The FWS has expressed concern that the NO_2 and SO_2 increments for the Breton National Wilderness Area have been consumed. The MMS is addressing FWS concerns with scientific study, now underway, to determine the pollutant increment status at BNWA. There is no PSD Class I air quality area in the WPA.

Air quality depends on multiple variables; the location and quantity of emissions, dispersion rates, distances from receptors, and local meteorology. Meteorological conditions and topography may confine, disperse, or distribute air pollutants in a variety of ways.

3.1.2. Water Quality

For the purposes of this EIS, water quality is the ability of a waterbody to maintain the ecosystems it supports or influences. In the case of coastal and marine environments, the quality of the water is influenced by the rivers that drain into the area, the quantity and composition of wet and dry atmospheric deposition, and the influx of constituents from sediments. Besides the natural inputs, human activity can contribute to water quality through discharges, run-off, dumping, air emissions, burning, and spills. Also, mixing or circulation of the water can either improve the water through flushing or be the source of factors contributing to the decline of water quality.

Evaluation of water quality is done by measurement of factors that are considered important to the health of an ecosystem. The primary factors influencing coastal and marine environments are temperature, salinity, dissolved oxygen, nutrients, potential of hydrogen (pH), oxidation reduction potential (Eh), pathogens, and turbidity or suspended load. Trace constituents such as metals and organic compounds can affect water quality. The water quality and sediment quality may be closely linked. Contaminants, which are associated with the suspended load, may ultimately reside in the sediments rather than the water column.

The region under consideration is divided into coastal and marine waters for the following discussion. Coastal waters, as defined by MMS, include all the bays and estuaries from the Rio Grande River to the Florida Bay (**Figure 3-2**). Marine water as defined in this document includes both State offshore water and Federal OCS waters, which includes everything outside any barrier islands to the Exclusive Economic Zone. The inland extent is defined by the Coastal Zone Management Act.

3.1.2.1. Coastal Waters

Along the Gulf Coast lies one of the most extensive estuary systems in the world, which extends from the Rio Grande River to Florida Bay (**Figure 3-2**). Estuaries represent a transition zone between the freshwater of rivers and the higher salinity waters offshore. These bodies of water are influenced by freshwater and sediment influx from rivers and the tidal actions of the oceans. The primary variables that influence coastal water quality are water temperature, total dissolved solids (salinity), suspended solids (turbidity), and nutrients. An estuary's salinity and temperature structure is determined by hydrodynamic mechanisms governed by the interaction of marine and terrestrial influences, including tides, nearshore circulation, freshwater discharges from rivers, and local precipitation. Gulf Coast estuaries exhibit a general east to west trend in selected attributes of water quality associated with changes in regional geology, sediment loading, and freshwater inflow.

Estuaries provide habitat for plants, animals, and humans. Marshes, mangroves, and seagrasses surround the Gulf Coast estuaries and provide food and shelter for shorebirds, migratory waterfowl, fish, invertebrates (e.g., shrimp, crabs, and oysters), reptiles, and mammals. Estuarine-dependent species constitute more than 95 percent of the commercial fishery harvests from the GOM. Estuarine ecosystems are impacted by humans, primarily via upstream usage of water for agricultural, industrial, and domestic purposes; contamination by industrial and sewage discharges, agricultural runoff carrying pesticides and herbicides, and urban and suburban runoff carrying oils, chemicals, and nutrients; and habitat alterations (e.g., construction and dredge and fill operations). When runoff flows through the surrounding coastal wetlands (**Chapter 3.2.1.2**), suspended particulate material is trapped and nutrients are incorporated into vegetation, resulting in improved water quality.

Population growth in coastal areas can impact water quality. Since 1960 the population of the coastal counties of the Gulf Coast States has increased by more than 100 percent. From 2000 to 2004 the population expanded by 6.7 percent. Population growth results in additional clearing of the land, excavation, construction, expansion of paved surface areas, and drainage controls (U.S. Commission on Ocean Policy, 2004a and b). These activities alter the quantity, quality, and timing of freshwater runoff. Storm water runoff, which flows across impervious surfaces such as parking lots, is more likely to be warmer and to transport contaminants associated with urbanization. These include suspended solids, heavy metals and pesticides, oil and grease, and nutrients.

Gulf Coast water quality was given a fair rating in the National Coastal Condition Report II (USEPA, 2004a). Five factors—dissolved oxygen, dissolved inorganic nitrogen, dissolved inorganic phosphorus, chlorophyll *a,* and water clarity—were used to rate water quality. Dissolved oxygen is essential for aquatic life, and low levels can result in mortality to benthic organisms and other organisms that cannot escape. The nutrients, nitrogen and phosphorous, are necessary in small amounts but can stimulate excessive phytoplankton growth. Chlorophyll *a* is a measurement of phytoplankton productivity. Water with greater clarity can support more submerged aquatic vegetation, which stabilizes the shoreline from erosion, reduces the impact of nonpoint source pollution, and provides habitat for many species.

Estuaries with a poor water quality rating comprised 9 percent of the Gulf Coast estuaries, while those ranked fair to poor comprised 55 percent. In Texas and Louisiana, estuaries that received a poor water quality rating in the report had low water clarity and high dissolved inorganic phosphorus in comparison to levels expected for that region. In Florida and Mississippi estuaries, the factors that contributed to a poor water quality rating were low water clarity and high chlorophyll relative to expected levels. Chlorophyll is one of several symptoms of eutrophic conditions. Dissolved oxygen levels in Gulf Coast estuaries are good and less than 1 percent of bottom waters exhibit hypoxia (dissolved oxygen below 2 milligrams (mg) per liter (L) O_2 mg/L).

Sediments can serve as a sink for contaminants that were originally transported via water in either dissolved or particulate form or via atmospheric deposition. Sediments may contain pesticides, metals, and organics. The sediments of Gulf Coast estuaries were ranked as fair. Metals were the type of sediment contamination found to most frequently exceed toxicity guidance.

The priority water quality issues identified by the Gulf of Mexico Alliance are bacterial-related beach and shellfish bed closures, estuarine hypoxia, harmful algal blooms, and seafood, particularly mercury, contamination. Nutrient loading was also identified as a regional action item (Gulf of Mexico Alliance, 2005). The Alliance was organized in 2005 as a collaborative means to solve regional problems to implement the U.S. Ocean Action Plan.

The passage of a hurricane serves to mix and transport waters. Winds can transport coastal waters to the inner shelf or force waters with higher salinity inland. Winds and waves resuspend bottom sediments, resulting in temporarily elevated levels of suspended solids in the water column. Contaminants sequestered in sediments, for example tributyltin, may be redistributed. Similarly, nutrients in sediments may be re-introduced into the water column and result in increased phytoplankton activity.

Hurricanes Katrina and Rita caused extensive flooding and damage to industrial and municipal waste facilities and to residential and commercial structures. Industrial and agricultural chemicals, household chemicals, sewage, oil, and nutrients contained in the flood waters had the potential to degrade water quality in coastal areas. The flood waters of New Orleans contained elevated bacterial levels and were oxygen depleted, but it was generally typical of storm water when pumped into Lake Pontchartrain (Pardue et al., 2005). Testing following the storm identified low levels of fecal coliform in Mississippi Sound and Louisiana coastal waters. Very few toxics were detected in estuarine or coastal waters resulting from the hurricanes (USEPA, 2006a).

The floodwaters contained the pollutants at about the same concentrations as typical storm water run-off. With the passage of days to a few months, the bacteria associated with sewage died off, the suspended load settled, and the water quality in the coastal areas recovered. Recovery in areas with hotspots of contamination, such as those surrounding the oil spills or greatly increased salinity, face a longer recovery or may not return to their original condition.

The Gulf Coast States sample the edible tissue of estuarine and marine fish for total mercury. The USEPA merged both State and Federal mercury data into the Gulfwide Mercury in Tissue Database to characterize the occurrence of mercury in GOM fishery resources (Ache et al., 2000). The reports found that all Gulf Coast States have published fish consumption advisories for large king mackerel. The report recommends testing of additional species through a Gulfwide coordinated approach. Additional data needs on mercury sources and bioaccumulation specific to the GOM are described by the National Science and Technology Council (NSTC, 2004).

3.1.2.2. Marine Waters

The marine water, within the area of interest, can be divided into three regions: the continental shelf west of the Mississippi River, the continental shelf east of the Mississippi River, and deepwater (>400 m; >1,312 ft). For this discussion, the continental shelf includes the upper slope to a water depth of 400 m (1,312 ft). While the various parameters measured to evaluate water quality do vary in marine waters, one parameter, pH, does not. The buffering capacity of the marine system is controlled by carbonate and bicarbonate, which maintain the pH at 8.2.

Continental Shelf West of the Mississippi River

The Mississippi and Atchafalaya Rivers are the primary sources of freshwater, sediment, and pollutants to the continental shelf west of the Mississippi (Murray, 1997). The drainage basin that feeds the rivers covers 55 percent of the contiguous U.S. While the average river discharge from the Mississippi River exceeds the input of all other rivers along the Texas-Louisiana coast by a factor of 10, during low-flow periods, the Mississippi River can have a flow less than all the other rivers combined (Nowlin et al., 1998). This area is highly influenced by input of sediment and nutrients from the Mississippi and Atchafalaya Rivers. A turbid surface layer of suspended particles is associated with the freshwater plume from these rivers. A nepheloid layer composed of suspended clay material from the underlying sediment is always present on the shelf. The river system supplies nitrate, phosphate, and silicate to the shelf. During summer months, the low-salinity water from the Mississippi River spreads out over the shelf, resulting in a stratified water column. While surface oxygen concentrations are at or near saturation, hypoxia (dissolved oxygen O_2 less than 2 mg/L), is observed in bottom waters during the summer months.

The zone of hypoxia on the Louisiana-Texas shelf is one of the largest areas of low oxygen in the world's coastal waters (Murray, 1997) (**Figure 3-3**). The oxygen-depleted bottom waters occur seasonally and are affected by the timing of the Mississippi and Atchafalaya Rivers' discharges carrying nutrients to the surface waters. This, in turn, increases the carbon flux to the bottom, which, under stratified conditions, results in oxygen depletion to the point of hypoxia. The hypoxic conditions last until local wind-driven circulation mixes the water again. The average size of the hypoxic zone increased from 2.1 million ac (0.8 million ha, 8,300 km^2) during 1985-1992 to over 4 million ac (1.6 million ha, 16,000 km^2) during 1993-2001. The largest year measured was 2002 when the hypoxic zone occupied 5.4 million ac (2.2 million ha, 22,000 km^2) (Rabalais, 2005). Increased nutrient loading since the turn of the 19th century correlates with the increased extent of hypoxic events (Eadie et al., 1994), supporting the theory that hypoxia is related to the nutrient input from the Mississippi and Atchafalaya River systems. Phosphorus may play a larger role than originally suspected and in its 2005 Reassessment, the Hypoxia Task Force will review the role of phosphorus in the occurrence of hypoxic conditions (USEPA, 2005b).

Shelf waters or sediments off the coast of Louisiana may contain trace levels of organic pollutants including polynuclear aromatic hydrocarbons (PAH), herbicides such as Atrazine, chlorinated pesticides, and polychlorinated biphenyls (PCB), and trace inorganic (metals) pollutants, for example, mercury. The concentrations of chlorinated pesticides and PCB's, which are associated with suspended particulates and sediment, continue to decline since their use has been discontinued. The source of these contaminants is the river water that feeds into the area.

Continental Shelf East of the Mississippi River

Water quality on the continental shelf from the Mississippi River Delta to Tampa Bay is influenced by river discharge, run-off from the coast, and eddies from the Loop Current. The Mississippi River accounts for 72 percent of the total discharge onto the shelf (SUSIO, 1975). The outflow of the Mississippi River generally extends only 45 mi (75 km) to the east of the river mouth (Vittor and Associates, Inc., 1985) except under extreme flow conditions. The Loop current intrudes in irregular intervals onto the shelf, and the water column can change from well mixed to highly stratified very rapidly. Discharges from the Mississippi River can be easily entrained in the Loop Current. The flood of 1993 provided an infusion of fresh water to the entire northeastern GOM shelf with some Mississippi River water transported to the Atlantic Ocean through the Florida Straits (Dowgiallo, 1994). Hypoxia is rarely observed on the Mississippi-Alabama shelf, although low dissolved oxygen values of 2.93-2.99 mg/L were observed during the MAMES and NEGOM cruises (Brooks, 1991; Jochens et al., 2002).

The Mississippi-Alabama shelf sediments are strongly influenced by fine sediments and nutrients discharged from the Mississippi River. The shelf area is characterized by a bottom nepheloid layer and surface lenses of suspended particulates that originate from river outflow. The West Florida Shelf has very little sediment input with primarily high-carbonate sands offshore and quartz sands nearshore. The water clarity is higher towards Florida, where the influence of the Mississippi River outflow is rarely observed.

A three-year, large-scale marine environmental baseline study conducted from 1974 to 1977 in the Eastern GOM resulted in an overview of the Mississippi, Alabama, and Florida (MAFLA) OCS environment to 200 m (656 ft) (SUSIO, 1977; Dames and Moore, 1979). Analysis of water, sediments, and biota for hydrocarbons indicated that the MAFLA area is pristine, with some influence of anthropogenic and petrogenic hydrocarbons from river sources. Analysis of trace metal contamination for the nine trace metals analyzed (barium, cadmium, chromium, copper, iron, lead, nickel, vanadium, and zinc) also indicated no contamination. A decade later, the continental shelf off Mississippi and Alabama was revisited (Brooks, 1991). Bottom sediments were analyzed for high-molecular-weight hydrocarbons and heavy metals. High-molecular-weight hydrocarbons can come from natural petroleum seeps at the seafloor or recent biological production as well as input from anthropogenic sources. In the case of the Mississippi-Alabama shelf, the source of petroleum hydrocarbons and terrestrial plant material is the Mississippi River. Higher levels of hydrocarbons were observed in the late spring, which coincides with increased river influx. The sediments, however, are washed away later in the year, as evidenced by low hydrocarbon values in winter months. Contamination from trace metals was not observed (Brooks, 1991).

The SAIC (1997) summarized information about water quality on the shelf from DeSoto Canyon to Tarpon Springs and from the coast to 200-m (656-ft) water depth. Several small rivers and the Loop Current are the primary influences on water quality in this region. Because there is relatively little onshore development in this area, the waters and surface sediments are uncontaminated. The Loop Current flushes the area with clear, low-nutrient water.

The NEGOM chemical oceanography and hydrography study (1997-2000) noted that interannual variation in the parameters measured outweighed seasonal variation due to the influence of offshelf circulation features and interannual variation in wind (Jochens et al., 2002). The average water–column, particulate matter mass on the Florida shelf remained within a narrow range and was half of that measured on the Mississippi and Alabama shelf. The cruise average particulate matter in the bottom nepheloid layer over the Florida shelf was similarly both lower and less variable than on the Mississippi and Alabama shelf. The highest chlorophyll *a* amounts measured in near-surface water were located in the areas influenced by the Mississippi and Apalachicola Rivers. Hypoxia was not observed on the shelf during the 3 years of the study.

Deep Water

Limited information is available on the deepwater environment. Water at depths greater than 1,400 m (4,593 ft) is relatively homogeneous with respect to temperature, salinity, and oxygen (Nowlin, 1972; Pequegnat, 1983; Gallaway et al., 1988). Of importance, as pointed out by Pequegnat (1983), is the flushing time of the GOM. Oxygen in deep water must originate from the surface and be mixed into the deep water by some mechanism. The major source of oxygen in deep waters is the transport of oxygen-rich water through the Yucatan Channel. Available data indicate that oxygen replenishment is adequate to balance oxygen consumption in deep waters; however, localized areas of depleted oxygen could exist as the result of natural conditions or anthropogenic activities such as the discharge from oil and gas activities (Jochens et al., 2005).

Limited analyses of trace metals and hydrocarbons for the water column and sediments exist (Trefry, 1981; Gallaway et al., 1988). The MMS recently completed a field study of four drilling sites located in water depths of 1,033-1,125 m (3,389-3,691 ft) (CSA, 2006). The sampling design called for before and after exploratory or development drilling and captured the drilling-related changes that occur in sediments and sediment pore water. At the Viosca Knoll Block 916 site, the closest drilling activity had occurred 1.4 mi NNW (2.3 km) and two years prior to the study; no drilling had ever been performed at the Viosca Knoll Block 916 site. The site was located at a water depth of 1,125 m (3,691 ft) and 70 mi (120 km) from the mouth of the Mississippi River. At this relatively pristine site prior to drilling, the average sediment barium concentration was 0.087-0.109 percent. The average sediment mercury and cadmium concentrations were 71 nanogram (ng)/g and 0.22-0.28 μg/g, respectively. Dissolved oxygen reached zero at 1.6- to 3.5-cm (0.6-1.4 in) (sediment depth, and the average sediment total organic carbon (TOC) concentration was 1.44-1.54 percent. The range of total sediment PAH was 159-388 ng/g before drilling.

Hydrocarbon seeps are extensive throughout the continental slope and contribute hydrocarbons to the surface sediments and water column, especially in the Central GOM (Sassen et al., 1993a and b). MacDonald et al. (1993) observed 63 individual seeps using remote sensing and submarine observations. Estimates of the total volume of seeping oil vary widely from 29,000 bbl/yr (MacDonald, 1998a) to 520,000 bbl/yr (Mitchell et al., 1999). These estimates used satellite data and an assumed slick thickness. In addition to hydrocarbon seeps, other fluids leak from the underlying sediments into the bottom water along the slope. These fluids have been identified to have three origins: (1) seawater trapped during the settling of sediments; (2) dissolution of underlying salt diapirs; and (3) deep-seated formation waters (Fu and Aharon, 1998; Aharon et al., 2001). The first two fluids are the source of authigenic carbonate deposits while the third is rich in barium and radium and is the source of barite deposits such as chimneys.

3.2. Biological Resources

3.2.1. Sensitive Coastal Environments

The coastal environments discussed here are those barrier beaches, wetlands, and submerged vegetation that might be impacted by activities resulting from the proposed actions. Geographically, the discussion covers coastal areas that range from the State of Tamaulipas, Mexico, through Alabama in the U.S. Several geologic subareas are found along this coast. Although seemingly similar biological environments occur in each of those subareas, they vary significantly. For that reason, the following environmental descriptions of this coast are organized into four geologic subareas. Those areas are: (1) the barrier island complex of northern Tamaulipas, Mexico, and southern Texas; (2) the Chenier Plain of eastern Texas and western Louisiana; (3) the Mississippi River Delta complex of southeastern Louisiana; and (4) the barrier-island and Pleistocene-plain complex of Mississippi and Alabama.

The landmasses in these areas are relatively low. Some form broad flat plains with gradually sloping topographies. Tides there are diurnal and micro-tidal (**Table 3-2**). Tidal influences can be seen 25-40 mi inland in some areas of Louisiana, Texas, and Alabama, due to large bay complexes, channelization, and low topographies. Wind-driven tides are often dominant over the minimal gravity tides that occur there.

3.2.1.1. Coastal Barrier Beaches and Associated Dunes

The U.S. Gulf shoreline from the Mexican border to Florida is about 1,500 km (932 mi) long. Ocean-wave intensities around the Gulf are generally low to moderate. These shorelines are usually sandy beaches that can be divided into several interrelated environments. Generally, beaches consist of a shoreface, foreshore, and backshore. The shoreface slopes downward and seaward from the low-tidal water line, under the water. The nonvegetated foreshore slopes up from the ocean to the beach berm-crest. The backshore is found between the beach berm-crest and the dunes, and it may be sparsely vegetated. The berm-crest and backshore may occasionally be absent due to storm activity.

The dune zone of a barrier landform can consist of a single low dune ridge, several parallel dune ridges, or a number of curving dune lines that may be stabilized by vegetation. These elongated, narrow landforms are composed of wind-blown sand and other unconsolidated, predominantly coarse sediments.

Sand dunes and shorelines conform to environmental conditions found at its site. These conditions usually include waves, currents, wind, and human activities. When Gulf waters are elevated by storms, waves are generally larger and can overwash lower coastal barriers, creating overwash fans or terraces behind and between the dunes. With time, opportunistic plants will re-establish on these flat, sand terraces, followed by the usual vegetative succession for this area. Along more stable barriers, where overwash is rare, the vegetative succession in areas behind the dunes is generally complete. Vegetation in these areas of broad flats or coastal strands consists of scrubby woody vegetation, marshes, and maritime forests. Saline and freshwater ponds may be found among the dunes and on the landward flats. Landward, these flats may grade into wetlands and intertidal mud flats that fringe the shore of lagoons, islands, and embayments. In areas where no bay or lagoon separates barrier landforms from the mainland, the barrier vegetation grades into scrub or forest habitat of the mainland.

Larger changes to barrier landforms are primarily due to storms, subsidence, deltaic cycles, longshore currents, and human activities. Barrier landform configurations continually change, accreting and eroding, in response to prevailing and changing environmental conditions. Landform changes can be seasonal and cyclical, such as seen with the onshore movement of sand during the summer and offshore movement during the winter, which is due to seasonal meteorological and wave-energy differences. Non-cyclical changes in landforms can be progressive, causing landform movement landward, seaward, or laterally along the coast.

Lateral movement of barrier landforms is of particular importance. As headlands and beaches erode, their sediments are transported offshore or laterally along the shoreline. Eroding headlands typically extend sand spits that may encape marshes or previously open, shallow Gulf waters. By separating inshore waters from Gulf waters and slowing the dispersal of freshwater into the Gulf, movements of barrier landforms contribute to the area and diversity of estuarine habitat along a coast. Most barrier islands around the Gulf are moving laterally to some degree. Where this occurs, the receding end of the island is typically eroding; the leading end accretes. These processes may be continuous or cyclic.

Accumulations and movements of sediments that make up barrier landforms are often described in terms of regressive and transgressive sequences. Transgressive landforms dominate around the GOM. A transgressive sequence moves the shore landward, allowing marine deposits to form on terrestrial sediments. Transgressive coastal landforms around the Gulf have low profiles and are characterized by narrow widths; low, sparsely vegetated, and discontinuous dunes; and numerous, closely spaced, active washover channels. Landward movement or erosion of a barrier shoreline may be caused by any combination of the following factors: subsidence, sea-level rise, storms, channels, groins, seawalls, and jetties. These influences are discussed under the cumulative activities scenario (**Chapter 4.1.3.3**). Movement of barrier systems is not a steady process because the passage rates and intensities of cold fronts and tropical storms, as well as intensities of seasons, are not constant (Williams et al., 1992). A regressive sequence deposits terrestrial sediments over marine deposits, building land into the sea, as would be seen during deltaic land-building processes. Regressive barriers have high and broad dune profiles. These thick accumulations of sand may form parallel ridges.

Texas and Mexican Barrier Island Complex

The Gulf coastline of Texas is about 367 mi (590 km) long. The State of Tamaulipas, in northeastern Mexico, has a Gulf shoreline of about 235 mi (378 km). The barrier islands of both areas are mostly accreted sediments that were reworked from river deposits, previously accreted Gulf shores, bay and lagoon sediments, and exposed seafloors (White et al., 1986). This reworking continues today as these barrier beaches and islands move generally to the southwest (Price, 1958). During the period of about 1850-1975, net coastal erosion occurred in the following three groups of counties in Texas: (1) Cameron, Willacy, and southern Kenedy; (2) northern Matagorda, Brazoria, and southern Galveston; and (3) Jefferson, Chambers, and far northern Galveston (Morton, 1982). These generalized trends seem to be continuing.

Elevations of Galveston Island and Bolivar Peninsula beach ridges generally range from 1.5 to 3 m (5 to 10 ft) above sea level (Fisher et al., 1972). The beaches of Galveston Island and Bolivar Peninsula are locally eroding or accreting. Accreting shorelines have a distinct beach berm and a wide back beach. Eroding beaches are relatively narrow, and the beach berm and back beach may be absent. Construction of seawalls and jetties on Galveston Island has contributed to erosion there, as discussed further in **Chapter 4.1.3.3**.

Padre Island is moderately regressive; the shoreline is retreating and more land is being exposed. It is typically 1.5-3 m (5-10 ft) above sea level and occasionally overwashed by hurricane surges. On the northern portion, some dunes may rise 6-9 m (20-30 ft) and the dune ridge is generally continuous. On the southern portion, the dune ridge is a series of short discontinuous segments. The dry winds and arid nature of this southern portion destabilize sand dunes. Sand flats and coppice dunes occupy the southern portion of the island. Any activity that reduces the sparse vegetation cover of this area initiates erosion. Vegetation on Padre Island is generally sparse, becoming sparser on its southern portion. The vegetation largely consists of grasses and scrubby, woody growth (Brown et al., 1977).

Exceptions to the above are the once regressive Matagorda Peninsula and Rio Grande Headland. The Matagorda Peninsula accreted as the Brazos-Colorado River Delta. Later, the peninsula became transgressive and the sediments were reworked to form flanking arcs of barrier sand spits. Washover channels cut the westward arc of the peninsula, forming barrier islands. The Rio Grand Headland has also become transgressive and sand spits formed to its north and south. Today, longshore drift is southerly at these sites. Their northern spits are now eroding and their southern spits are accreting.

The Chenier Plain

The Chenier Plain of eastern Texas and western Louisiana began developing about 2,800 years ago. During that period, Mississippi River Delta sediments were intermittently eroded, reworked, and carried into the Chenier Plain area by storms and coastal currents. This deposition gathered huge volumes of mud and sand, forming a shoreface that slopes very gently, almost imperceptibly, downward for a very long distance offshore. This shallow mud bottom is viscous and elastic, which generates hydrodynamic friction (Bea et al., 1983). Hence, wave energies along the barrier shorelines of the Chenier Plain are greatly reduced, causing minimal longshore sediment transport along the Chenier Plain (USDOI, GS, 1988). More recently, this shoreline has been eroding as sea level rises, converting most of this coast to transgressive shorelines.

Today, the Red River and about 30 percent of the Mississippi River are diverted to the Atchafalaya River. The diversions have increased the sediment load in the longshore currents, which generally move slowly westward along the coast.

The barrier beaches of the Chenier Plain are generally narrow, low, and sediment starved due to the natures of coastal currents and the shoreface. Here and there, beach erosion has exposed relic marsh terraces that were buried by past overwash events. West of about Fence Lake, Texas, the beach is fairly typical, being composed of shelly sand; although, it is no more than 200 ft wide. Its shoreface sediments are similar (Fisher et al., 1973). East of Fence Lake, the shoreface contains discontinuous mud deposits among muddy sands. During low tides, extensive mudflats are exposed east and west of Fence Lake. The beach in this area is much narrower and becomes a low escarpment, where wave action cuts into the salt marsh (Fisher et al., 1973). Hurricane Rita (September 2005) severely impacted the shoreface and beach communites of Cameron Parish in southwest Louisiana. Some small towns in this area have no standing structures remaining. A storm surge approaching 6 m (20 ft) caused beach erosion and overwash, which flattened coastal dunes depositing sand and debris well into the backing marshes.

The Mississippi River Delta Complex

Most barrier shorelines of the Mississippi River Delta in Louisiana are transgressive and trace the seaward remains of a series of five abandoned deltas. The Mississippi River is channelized through the Belize Delta, more commonly known as the Birdfoot Delta. Channelization isolated the river from most of this sixth delta, except near the distributary mouths. There, a small fraction of the river's sediment load is contributed to longshore currents for building and maintaining barrier shores. The bulk of river sediments are deposited in deep water, where they cannot be reworked and contribute to the longshore sediment drift. Most of southeastern Louisiana's barrier beaches are composed of medium to coarse sand.

The shorefaces of the Mississippi River Delta complex generally slope very gently seaward, which reduces wave energies at the shorelines. Mud flats are exposed during very low tidal events. The slope here is not as shallow as that found off the Chenier Plain. The steepest shoreface of the delta is found at the Caminada-Moreau Coast, where the greatest rates of erosion are seen. At this site, the long shore currents split to the east and west, which removes sand from the area without replenishing the area (Wolfe et al., 1988; Wetherell, 1992; Holder and Lugo-Fernandez, 1993).

Regressive shorelines do occur in Louisiana's deltaic region. The diversion of the Red River and about 30 percent of the Mississippi River to the Atchafalaya River has allowed transport of large volumes of sediment into shallow Atchafalaya Bay. There, inland deltas are forming at the mouths of that river and Wax Lake Outlet, which are discussed more fully under **Chapter 3.2.1.2**. Satellite photography of these deltas reveals that dredge-disposal islands were constructed off Point au Fer in very shallow water (3-5 ft) at the mouth of Atchafalaya Bay. These islands and the surrounding shallows are the foundations for a future barrier shoreline in this area, if the Atchafalaya River Delta continues to build seaward as expected.

Smaller shoreline regressions also occur as a result of jetties located on the eastern end of Grand Isle, the western end of Caminada-Moreau Beach, Empire navigational canal, and elsewhere. The circumstances of these situations are discussed more completely in **Chapter 3.2.1.2**.

Most dune zones of the Mississippi River Delta contain low, single-line dune ridges that may be sparsely to heavily vegetated. Generally in this area, the vegetation on a dune ridge gets denser as the time between storms lengthens. Unfortunately, the past decade has seen an increase in tropical storm activity for the project area. Hurricane Katrina (August 2005) caused severe erosion and landloss for the coastal barrier islands of the Deltaic Plain. The eye of Hurricane Katrina passed directly over the 50-mi (80-km) Chandeleur Island chain. Aerial surveys conducted by the U.S. Geological Survey on September 1, 2005, show that these islands were heavily damaged by the storm (USDOI, GS, 2006a). Although barrier islands and shorelines have some capacity to regenerate over time, the process is very slow and often incomplete. With each passing storm, the size and resiliency of these areas can be diminished, especially when major storms occur within a short time period. Hurricane Katrina was the fifth hurricane to impact the Chandeleur Island chain in the past 8 years. The other storms were Hurricanes Georges (1998), Lili (2002), Ivan (2004), and Dennis (2005). Land mass rebuilt since Hurricane Ivan was washed away by Hurricane Katrina. The Chandeleur Islands were reduced by Hurricane Katrina from 5.64 mi^2 to 2.5 mi^2 and then to 2.0 mi^2 by Hurricane Rita (Di Silvestro, 2006).

Grand Isle was also heavily damaged by Katrina. Although Katrina made landfall more than 50 mi (80 km) to its east, Grand Isle received extremely high winds and a 12- to 20-ft (3.5- to 6-m) storm surge that caused tremendous structural damage to most of its camps, homes, and businesses (Louisiana Sea Grant, 2006a).

Boyd and Penland (1988) estimated that storms raise mean water levels 1.73-2.03 m (5.68-6.66 ft) above mean sea level 10-30 times per year. Under those conditions, barrier islands of the Mississippi River Delta complex experience severe overwash of up to 100 percent.

Shell Key is an emerged barrier feature that varies greatly from the others around the Delta. It is located south of Marsh Island, Louisiana, at the mouth of Atchafalaya Bay, and is composed almost entirely of oyster-shell fragments. It is found amid extensive shell reefs, which are part of the Shell Keys National Wildlife Refuge. This dynamic, minimally vegetated island builds and wanes with passing storms. In 1992 and 1999, Hurricanes Andrew and Francis reduced the island to little more than a shoal that largely submerges under storm tides. The shallow, submerged shell reefs around Shell Key also serve as barrier features. Located on the other side of the bay's mouth and to the southeast, the Point au Fer Shell Reefs were commercially dredged for shells, and no longer exist (USDOI, FWS, 2001; Schales and Soileau, personal communication, 2001)

Mississippi and Alabama Coasts

The Dog Keys define the Mississippi Sound of Mississippi and Alabama. Mississippi has about 33.9 mi (54.6 km) of barrier beaches on these islands (USDOI, FWS, 1999). Dauphin Island represents about another 7 mi (12 km). This relatively young group of islands was formed 3,000-4,000 years ago as a result of shoal-bar accretion (Otvos, 1979). They are separated by wide passes with deep channels. Shoals are typically adjacent to these barriers. Generally, these islands are regressive and stable in size as they migrate westwardly in response to the predominantly westward-moving longshore currents.

These islands generally have high beach ridges and prominent sand dunes. Although overwash channels do not commonly occur, the islands may be overwashed during strong storms as was seen after Hurricanes Ivan (2004), Dennis (2005), and Katrina (2005). The islands are well vegetated among and behind the dunes and around ponds. Southern maritime climax forests of pine and palmetto are found behind some of their dune fields.

Dauphin Island, Alabama, is the exception to the above description. It is essentially a low-profile transgressive barrier island, except for a small, eroding, Pleistocene core at its eastern end. The western end is a Holocene spit that is characterized by small dunes and many washover fans, exposed marsh deposits, and tree stumps exposed in the surf zone. Dauphin Island experienced significant shoreline retreat and rollover after Hurricane Katrina, with overwash deposits forming in the sound.

Pelican Island, Alabama, is a vegetated sand shoal, located Gulfward of Dauphin Island. Southeasterly of that island is Sand Island, which is little more than a shoal. These barrier islands are parts of Mobile Bay's ebb-tidal delta. As such, they continually change shape under storm and tidal pressures. Their sands generally move northwesterly into the longshore drift, nourishing beaches down drift. These sediments may also move landward during flood tides (Hummell, 1990).

The Gulf Shores region of Alabama extends from Mobile Point eastward to the Florida boundary, a distance of about 31 mi (50 km) (Smith, 1984). It has the widest beaches and largest dune system among the barrier beaches discussed.

3.2.1.2. Wetlands

According to the U.S. Dept. of the Interior (Dahl, 1990; Henfer et al., 1994), during the mid-1980's, 4.4 percent of Texas (3,083,860 ha) (Henfer et al., 1994), 28 percent of Louisiana (3,557,520 ha), 14 percent of Mississippi (17,678,730 ha), and 8 percent of Alabama (1,073,655 ha) were considered wetlands. More recent information is provided below by geographic area, including recent land change as a result of Hurricanes Katrina and Rita. The most notable was the 217 mi^2 of Louisiana's coastal lands that were transformed to water after Hurricanes Katrina and Rita (Barras, 2006).

The importance of coastal wetlands to the coastal environment has been well documented. One of the important functions of coastal marshes and barrier islands is as a front line of defense against storm surge.

High organic productivity and efficient nutrient recycling are characteristic of coastal wetlands. They provide habitat for a great number and wide diversity of resident plants, invertebrates, fishes, reptiles, birds, and mammals. Marsh environments are particularly important nursery grounds for many economically important fish and shellfish juveniles. The marsh edge, where marsh and open water come together, is particularly important for its higher productivity and greater concentrations of organisms. Emergent plants produce the bulk of the energy that supports salt-marsh dependent animals. Freshwater-marsh environments generally contain a much higher diversity of plants and animals than do those of saline marshes.

Wetland habitats found along the Central and Western Gulf Coast include fresh, intermediate, brackish, and saline marshes; mud and sand flats; and forested wetlands of mangrove swamps, cypress-tupelo swamps, and bottomland hardwoods. Coastal wetland habitats occur as bands around waterways and as broad expanses. Saline and brackish habitats support sharply delineated, segregated stands of single plant species. Fresh and very low salinity environments support more diverse and mixed communities of plants. The plant species that occur in greatest abundance vary greatly around the Gulf. For those reasons, interested readers are referred to ecological characterization and inventory studies conducted by the FWS, in cooperation with other agencies; the Texas Bureau of Economic Geology; and other researchers (Gosselink et al., 1979; Smith, 1984; Fisher et al., 1972 and 1973; Brown et al., 1976 and 1977; Stout et al., 1981).

Gulf coastal wetlands also support the largest fur harvest in North America, producing 40-65 percent of the nation's yearly total in Louisiana (Olds, 1984). Gulf coastal wetlands support over two-thirds of the Mississippi Flyway wintering waterfowl population and much of North America's puddle duck population.

Texas Barrier Islands and Tamaulipas Coastal Wetlands

Landward of the barrier beaches of Texas, estuarine marshes largely occur as continuous and discontinuous bands around bays, lagoons, and river deltas. Broad expanses of emergent wetland vegetation do not commonly occur south of Baffin Bay because of the arid climate and hypersaline waters. In the vicinity of southern Padre Island, marshes are minimal and unstable, compared to the more northern Gulf. In Tamaulipas, marshes behind the barrier islands are even less abundant than seen in the vicinity of Padre Island. Dominant salt-marsh plants in southern regions include more salt-tolerant species such as *Batis maritima* and glasswort (*Salicornia sp*.).

Brackish marshes occur in less saline, inland areas and are divided into frequently and infrequently flooded marshes. Infrequently flooded marshes contain an assemblage of plants that are much more tolerant of dry conditions. Freshwater marshes in Texas occur inland above tidally delivered saline waters, in association with streams, lakes, and catchments. Broken bands of black mangroves (*Avicennia germinans*) also occur in this area (Brown et al., 1977; White et al., 1986).

Wind-tidal flats of mud and sand are mostly found around shallow bay margins and in association with shoals. As one goes farther south from Corpus Christi and into Tamaulipas, flats increasingly replace lagoonal and bay marshes. Laguna Madre of Texas is divided into northern and southern parts by the wind-tidal flats of the Land-Cut Area, just south of Baffin Bay. The Intracoastal Waterway is dredged through this area, as are a series of well access channels. Dredging has caused topographic and vegetative changes among the flats of Laguna Madre.

Frequently flooded flats usually remain moist and may have mats of blue-green algae and an area-specific assemblage of invertebrates. Infrequently flooded flats are at higher elevations where only tides that are driven by strong wind can flood them. These are better drained and much dryer. Higher tidal flats remain barren because of the occasional saltwater flooding and subsequent evaporation that raises salt concentrations in the soil. This inhibits most plant growth; some salt-marsh plants that are tolerant of dry conditions may be found there. Some higher flats are non-tidal, barren fan deltas and barren channel margins along streams. The salt concentrations of these soils are often elevated also (Brown et al., 1977; White et al., 1986).

Inland beaches of sand and shells are found along the shores of bays, lagoons, and tidal streams. The structure of these beaches is similar to, but much narrower and smaller in scale than, barrier beaches. Compared to the sand beaches, shell features are typically stacked to higher elevations by storm waves and are generally more stable.

Few freshwater swamps and bottomland hardwoods occur in the general vicinity of OCS-related service bases and navigational channels of the Texas barrier island area. In the southern third of this area, they are nonexistent (Brown et al., 1977; White et al., 1986).

Chenier Plain

Beginning about 2,800 years ago and as sea level dropped during the last ice age, sediments from the Mississippi River and its delta were intermittently reworked and deposited by storms and coastal currents, forming the Chenier Plain between Port Bolivar, Texas, and Atchafalaya Bay in Louisiana. As the area filled in, a series of shell and sand ridges were formed parallel or oblique to the present-day Gulf Coast and were later abandoned as sea level continued to fall. Mudflats formed between the ridges when localized hydrologic and sedimentation patterns favored deposition there. This intermittent deposition isolated entrenched valleys from the Gulf, forming large lakes such as Sabine, Calcasieu, White, Grand, and others (Gosselink et al., 1979; Fisher et al., 1973). As a result, few tidal passes are found along this coast as compared to central Texas and eastern Louisiana. This reduces the tidal movement of saline waters.

Because of the structure of the Chenier Plain and its beaches, salt marshes are not as widely spread there as elsewhere in the northern Gulf. Generally in this area, salt marshes front the Gulf directly and are frequently submerged by tides and storms. Hence, they are considered high-energy environments, as compared to most vegetated wetlands.

Brackish and intermediate salinity marshes are dominant in estuarine areas of the Chenier Plain. They are tidal, although wind-driven tides are more influential and occasionally inundate these areas. Since salinity in this area ranges broadly, these habitats support a mix of salt and salt-tolerant freshwater plants, although marsh-hay cordgrass is generally dominant. These habitats are the most extensive and productive in coastal Louisiana.

Plant communities of freshwater marshes are among the most diverse of sensitive coastal environments. Annuals have a much greater presence in freshwater marshes than in estuarine areas.

Dominance often changes from season to season as a result of year-round seed-germination schedules. Freshwater wetlands are extensive in the Chenier Plain due to the abundant rainfall and runoff coupled with the ridge system that retains freshwater and restricts the inflow of saline waters. Tidal influences are generally minimal in these areas, although strong storms may inundate the area. Hence, detritus is not as readily exported and accumulates there, supporting additional plant growth. Freshwater marsh plants are generally more buoyant than estuarine plants. In areas where detritus collects thickly, marsh plants may form floating marshes, referred to as "flotants." Flotants generally occur in very low-energy environments. They are held together by surrounding shorelines and a weave of slowly deteriorating plant materials and living roots.

Forested wetlands are not very common in the Chenier Plain. They only occur in the flood plain regions of major streams, along the northern margin of this area. There, cypress-tupelo swamps grade through stands of blackwillow to bottomland hardwoods.

Hurricane Rita made landfall in September 2005 along the Texas/Louisiana coast. It may be years before the full extent of impacts is known. The impacted area is home to four Federal and three State wildlife refuges, from the 124,511-ac Sabine National Wildlife Refuge in Cameron Parish to the Bayou Teche National Wildlife Refuge near Franklin (9,000 ac set aside in 2001 as habitat for the Louisiana black bear). Some inland freshwater marshes, bottomland swamps, and hardwood forests were inundated with up to 4 ft (1.5 m) of saltwater. The land change caused by Hurricane Rita amounts to approximately 100 mi^2 of land change (Barras, 2006).

Mississippi River Delta Complex

Mississippi River Delta Complex forms a plain that is composed of a series of overlapping riverine deltas that have extended onto the continental shelf over the past 6,000 years. Wetlands on this deltaic plain are the most extensive of those within this EIS's area of attention.

Sparse stands of black mangrove are found here and there, in the highest salinity areas of the Barataria and Terrebonne Basins. Extensive salt and brackish marshes are found throughout the southern half of the plain and east of the Mississippi River. Further inland, extensive intermediate and fresh water marshes are found. East of the Mississippi River and south of Lake Pontchartrain, Louisiana, very few intermediate and freshwater wetlands were found until the Caernarvon Freshwater Diversion was intermittently put into action in 1993. In freshwater areas, cypress-tupelo swamps are found flanking the natural levees and in areas that are impounded by dredged materials, levees, or roads. Bottomland hardwoods are found on the numerous natural levees and in drained levee areas

Except for leveed areas and the delta and basin of the Atchafalaya River, all of these deltas are generally experiencing succession towards wetter terrestrial and deeper water habitats. This is due to deltaic abandonment and human actions and their ensuing erosion. Most of these wetlands are built upon highly organic soils, which are easily eroded, compacted, and oxidized. These problems are discussed in **Chapter 4.1.3.3**.

Two active deltas are found in this area. The more active is in Atchafalaya Bay, at the mouths of the Atchafalaya River and its distributary, Wax-lake Outlet. Because the Red River and about thirty percent of the Mississippi River have been diverted to the Atchafalaya River, large volumes of sediment are being delivered to that shallow bay. As a result, extensive freshwater marshes, swamps, and bottomland hardwoods are found in this river basin. Relatively few estuarine marshes are found there.

The less active delta is at the mouth of the Mississippi River, which is referred to as the Belize or Birdfoot Delta. The Mississippi River has been channelized through most of this delta, which greatly reduced the volume of sediments that it contributes to the delta and longshore currents near the mouths of its distributaries. A few man-made diversions have been installed that are designed to deliver water rather than sediments to this delta. See **Chapter 4.1.3.3** for a fuller description of these circumstances.

In the aftermath of Hurricanes Katrina and Rita, scientists with State and Federal government agencies, universities, and nongovernmental organizations have begun analyzing the losses to the coastal wetlands and barrier islands of the Gulf Coast. Louisiana in particular is highly susceptible to hurricanes. Although Louisiana's coastal marshes and barrier islands provide a front line of defense against storm surge, 90 percent of these wetlands are at or below sea-level elevation. Furthermore, Louisiana is historically prone to major storm events. According to the LSU Hurricane Center, the central Louisiana coast has experienced landfall of more major hurricanes (Category 3 and above) than anywhere in the continental U.S. over the past century (LSU Hurricane Center, 1999).

The USGS National Wetlands Research Center reported a total of 217 mi^2 of Louisiana's coastal lands were transformed to water after Hurricanes Katrina and Rita (Barras, 2006). The permanency of this loss may not be known for several growing seasons as some of the shallow areas may recover rapidly while others may remain open ponds. According to a previous USGS report, the change from land to open water in all of coastal Louisiana east of the Mississippi River from 2004 to 2005 was 72.9 mi^2 (USDOI, GS, 2006b). The Louisiana Coastal Area Ecosystem Restoration Study (LCA, 2004) projected only 60 mi^2 of landloss for this area for the 50-year period ending 2050.

In general, brackish and saline marshes appeared to have fared better than fresh and intermediate marshes. The greatest impacts were observed in the fresh and intermediate marshes of the Mississippi River Basin, upper Breton Sound Basin, and Pearl River Basin. A breakdown by basin shows the following:

- Breton Sound water area increased by 40.9 mi^2;
- Terrebonne basin water area increased by 19.4 mi^2;
- Pontchartrain basin water area increased by 19.1 mi^2
- Mississippi River basin water area increased by 17.8 mi^2;
- Barataria basin water area increased by 17.6 mi^2;
- Pearl River basin water area increased by 4.4 mi^2; and
- Atchafalaya basin showed no change.

Mississippi and Alabama

Mississippi has approximately 72,000 ac (113 mi^2) of designated crucial coastal wetland habitat (Mississippi Dept. of Marine Resource, 2006). Estuarine wetlands are the second-most common wetlands in Mississippi, including coastal marsh, estuarine, fresh, mud flats and cypress-tupelo gum swamp (estuarine forested wetlands). Estuarine marshes around Mississippi Sound and associated bays occur in discontinuous bands. The most extensive wetland areas in Mississippi occur in the eastern Pearl River delta near the western border of the State and in the Pascagoula River delta area near the eastern border of the State. Mississippi's wetlands seem to be more stable than those in Louisiana and Alabama, perhaps reflecting the more stable substrate, more active and less disrupted sedimentation patterns in wetland areas, and the occurrence of only minor canal dredging and development. Urban and suburban growth are suggested as the greatest contributors to direct coastal wetland loss in Mississippi and Alabama (Moulton and Jacob, 2000).

Alabama has approximately 118,000 ac (184 mi^2) of coastal wetlands, of which approximately 75,000 ac (117 mi^2) are forested, 4,400 ac (9 mi^2) are freshwater marsh, and 35,400 ac (55 mi^2) are estuarine marsh (Wallace, 1996). Most coastal wetlands in Alabama occur on the Mobile River delta or along the northern Mississippi Sound.

3.2.1.3. Seagrass Communities

Three million hectares of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters of the northern GOM. An additional 166,000 ha (410,195 ac) are found in protected, natural embayments and are not considered exposed to OCS impacts. The area off Florida contains approximately 98.5 percent of all coastal seagrasses in the northern GOM; Texas and Louisiana contain approximately 0.5 percent. Mississippi and Alabama have the remaining 1 percent of seagrass beds.

Seagrass beds grow in shallow, relatively clear, and protected waters with predominantly sand bottoms. Their distribution depends on an interrelationship among a number of environmental factors that include temperature, water depth, turbidity, salinity, turbulence, and substrate suitability. Primarily because of low salinity and high turbidity, robust seagrass beds and the accompanying high diversity of marine species are found only within a few scattered, protected locations in the Western and Central

GOM. Inshore seagrasses provide important habitat for immature shrimp, black drum, spotted sea trout, juvenile southern flounder, and several other fish species; and they provide a food source for several species of wintering waterfowl.

Seagrasses in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass beds are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Although permanent meadows of perennial species occur in nearly all bay systems along the Texas Gulf Coast, most of the State's seagrass cover (79%) is found in the Laguna Madre (Pulich, 1998), with seagrasses covering about 60,047 ac (243 km^2) in the upper portion of the Laguna Madre (Quammen and Onuf, 1993). Seagrasses are largely excluded from bays north of Pass Cavallo where rainfall and inflows are high and salinity's average less than 20 ppt, as well as the upper, fresher portions of most estuaries. Seagrasses in the Laguna Madre constitute a unique resource that cannot be duplicated elsewhere on the Texas coast (Withers, 2001). Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays.

The turbid waters and soft, highly organic sediments of Louisiana's estuaries and offshore areas limit widespread distribution of higher salinity seagrass beds. Consequently, only a few areas in offshore Louisiana, mostly in Chandeleur Sound, support seagrass beds. These beds have been repeatedly damaged by the natural processes of transgression from hurricane overwash of the barrier islands. The Chandeleur Island chain has been hit by five storms in the past eight years including Hurricane Georges, Tropical Storm Isadore, Hurricane Ivan, Hurricane Lilli, and Hurricane Katrina (Michot and Wells, 2005). Storm-generated waves wash sand from the seaward side of the islands over the narrow islands, and cut new passes through the islands. The overwashed sand buries seagrass beds on the back side of the islands. Cuts formed in the islands erode channels that remove seagrass in its path. Over time, seagrass recolonizes the new sand flats on the shoreward side and the natural processes of sand movement rebuild the islands. Land mass rebuilt since Hurricane Ivan was washed away by Hurricane Katrina. The Chandeleur Islands were reduced by Hurricane Katrina from 5.64 mi^2 to 2.5 mi^2 and then to 2.0 mi^2 by Hurricane Rita (Di Silvestro, 2006).

Hurricane impacts can produce changes in seagrass community quality and composition. A survey of 44 stations in Alabama seagrass beds showed seagrasses still present in 86 percent of the stations after Hurricane Ivan's landfall at Mobile in September 2004. It also revealed the presence of widgeon grass, *Ruppia maritima*, at 17 stations (Heck and Byron, 2006). *Ruppia maritima* is tolerant of low salinities and colonizes some estuaries. The influx of salt water in low salinity estuaries caused by Hurricanes Katrina and Rita may lead to an increase in colonization by *Ruppia maritima* and a decrease in abundance of freshwater species such as *Vallisineria americana* in upper bay areas. Such a fluctuation in community composition was documented for Lake Pontchartrain, Louisiana, by Poirrier and Cho (2002) after Hurricane Georges landfall at Biloxi, Mississippi, in September 1998. Seagrasses in Bayou la Batre, Alabama, evidence reduced benthic and water column production since Hurricane Katrina made landfall at the eastern border of Louisiana, in August 2005 (Anton et. al, 2006).

The distribution of seagrass beds in coastal waters of the Western and Central GOM have diminished during recent decades. Primary factors believed to be responsible include dredging, dredged material disposal, coastal development including shore armoring, trawling, water quality degradation, hurricanes, a combination of flood protection levees that have directed freshwater and sediments away from wetlands, saltwater intrusion that moved growing conditions closer inland, and infrequent freshwater diversions from the Mississippi River into coastal areas during flood stage.

3.2.2. Sensitive Offshore Benthic Resources

3.2.2.1. Continental Shelf Benthic Resources

Seafloor (benthic) habitats, including live-bottom areas, topographic features, and deepwater benthic communities, are essential components of the overall offshore community assemblage in the GOM.

The pelagic offshore water-column biota contains primary producers (phytoplankton and bacteria—90 percent of the phytoplankton in the northern GOM is constituted by diatoms), secondary producers (zooplankton), and consumers (larger marine species including fish, reptiles, cephalopods, crustaceans, and marine mammals). The zooplankton consists of holoplankton (organisms for which all life stages are spent in the water column, including protozoans, gelatinous zooplankton, copepods, chaetognaths, polychaetes, and euphausids) and meroplankton (mostly invertebrate and vertebrate organisms for which larval stages are spent in the water column, including polychaetes, echinoderms, gastropods, bivalves, and fish larvae and eggs). Some species of plankton are able to swim and make vertical migrations, but their movements are dominated by water currents. The species diversity, standing crop, and primary productivity of offshore phytoplankton are known to fluctuate much less than their coastal counterparts as the offshore phytoplankton are less subject to changes of salinity, nutrient availability, vertical mixing, and zooplankton predation. In general, the diversity of pelagic planktonic species generally decreases with decreased salinity and biomass decreases with distance from shore. Temperature, salinity, and nutrient availability limit the geographical and vertical ranges of plankton and consumers. The fish species of the Gulf are temperate, with incursions of subtropical Caribbean faunas. Gulf fish species exhibit seasonal distribution and abundance fluctuations that are probably largely related to oceanographic conditions.

Another essential component of the offshore environment is the neuston, which is composed of organisms living at the air-seawater interface. Significant components of the neuston are copepods, jellyfish, floating *Sargassum* algae (also known as "*Sargassum* mats"), and the organisms associated with the *Sargassum*. As many as 100 different animal species can be found in the floating *Sargassum* in the Gulf. These species include mostly hydroids and copepods, but also contain fish, shrimp, crabs, gastropods, polychaetes, bryozoans, anemones, and sea spiders. The majority of these organisms depend on the presence of the *Sargassum* algae. *Sargassum* alga rafts potentially constitute long-term havens for young sea turtles, which drift with these floating ecosystems as they feed off their living organisms, possibly for several years.

Shelf phytoplankton and zooplankton are more abundant, more productive, and seasonally more variable than plankton over the deep Gulf. This is related to salinity changes, greater nutrient availability, increased vertical mixing, and different zooplankton predation in the shelf environment.

The benthos of the shelf has both floral and faunal components; floral representatives include bacteria, algae, and seagrasses. The abundance of benthic algae is limited by the scarcity of suitable substrates and light penetration. In exceptionally clear waters, benthic algae, especially coralline red algae, are known to grow in water depths to at least 180 m. Rezak et al. (1985) recorded algae from submarine banks off Louisiana and Texas. Seagrasses are not present offshore in the Western and Central Gulf; however, fairly extensive beds may be found in estuarine areas behind the barrier islands throughout the Gulf.

Benthic fauna include infauna (animals that live in the substrate, including mostly burrowing worms, crustaceans, and mollusks) and epifauna (animals that live on or are attached to the substrate; mostly crustaceans, as well as echinoderms, mollusks, hydroids, bryozoans, sponges, and soft and hard corals). Shrimp and demersal fish are closely associated with the benthic community. Substrate is the single most important factor in the distribution of benthic fauna (densities of infaunal organisms increase with sediment particle size) (Defenbaugh, 1976), although temperature and salinity are also important in determining the extent of faunal distribution. Depth and distance from shore also influence the benthic faunal distribution (Defenbaugh, 1976). Lesser important factors include illumination, food availability, currents, tides, and wave shock. The density of offshore infaunal organisms has been found to be greater during the spring and summer as compared to the winter (Brooks, 1991).

In general, the vast majority of bottom substrate available to benthic communities in the Central and Western Gulf consists of soft, muddy bottoms; the benthos here is dominated by polychaetes. Benthic habitats on the continental shelf at most risk to potential impacts from oil and gas operations are topographic features and the live-bottom (pinnacle trend) communities.

3.2.2.1.1. Live Bottoms (Pinnacle Trend)

The northeastern portion of the Central GOM exhibits a region of topographic relief known as the "Pinnacle Trend" at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and DeSoto Canyon. The MMS has sponsored numerous studies providing information about these features (Brooks, 1991; CSA, 1992a; Thompson et al., 1999; CSA with Texas A&M University Geochemical and Environmental Research Group, 2001). A recent bathymetric survey by the U.S. Geological Survey has provided accurate, up-to-date imaging of the seafloor of the region (Gardner et al., 2002a). The Pinnacle Trend covers 70 MMS lease blocks where the MMS has applied "live-bottom (Pinnacle Trend) stipulations" to protect the ecosystem (**Figure 2-1**). This area includes portions of the continental shelf, shelf break, and upper continental slope. The outer limit of the continental shelf is delineated by the 75-m (246-ft) depth contour. **Figure 3-4** is a perspective view of the central sector of the Mississippi-Alabama continental shelf. The area also spans differing sediment regimes. The eastern part of the pinnacles area is covered with a thin, well-sorted layer of fine- to medium-grained quartzose sand from eastern continental rivers. The western portion is covered with fine silts, sands, and clays deposited by the Mississippi River (CSA, 1992a). The pinnacles appear to be carbonate reefal structures in an intermediate stage between growth and fossilization (Ludwick and Walton, 1957). They generally have a southwest to northeast trend with many of the groups and linear features oriented in this direction. This orientation corresponds with depth contours and may represent a historic shoreline. The heavily indurated pinnacles provide a surprising amount of surface area for the growth of sessile invertebrates and attract large numbers of fish. Additional areas of hard bottom are located nearby on the continental shelf, outside the Pinnacle Trend.

Low Relief

The pinnacle region contains a variety of features from low-relief rocky areas to major pinnacles, as well as ridges, scarps, and relict patch reefs. This includes thousands of carbonate mounds ranging in size from less than a few meters in diameter to nearly a kilometer. Most of these features are of low relief, 1-2 m (3-6 ft) or less, and some occur in quite extensive groups. A low–relief, hard-bottom trend characterized by discontinuous bumpy rock outcrops lies in 61-79 m (200-260 ft) depths (Thompson et al., 1999). Continental Shelf Associates (CSA, 1992a) detected low–relief, hard-bottom features on the shelf and along the shelf break suspected to be similar to those described by Schroeder et al. (1988) on the Alabama shelf. This includes small, irregular outcrops of sandstone, massive to nodular sandstones and mudstones, calcite-cemented reef-like knobs, and slabby aragonite-cemented outcrops in ridges.

Shallow Depressions

Shallow depressions are another type of low-relief feature common in the pinnacle area, particularly in the western portion. These occur in large fields that do not follow depth contours. They are usually irregularly shaped with bumpy rims, 5-10 m (16-33 ft) across, and probably less than a meter in depth. It is thought that they are formed by the collapse of sediments following gas expulsion.

Reef-Like Mounds

Reef-like mounds are the most widespread features in the pinnacle region. They range in height from 1 to 20 m (3-66 ft) and in width from a few meters to over one-half kilometer (a few yards to over a quarter of a mile). They are mostly along two major depth bands: 74-82 m (243-269 ft) and 105-120 m (345-394 ft). Patch reefs are small reef-like mounds about 2-12 m (6-39 ft) in diameter and 3-4 m (10-13 ft) in height that occur in many areas. They are particularly abundant in fields of as many as 35-70 features per hectare (2.47 ac) along the 74- to 82-m (243- to 269-ft) isobath (Brooks, 1991). Flat-topped reefs are large reef-like mounds that occur along the same isobath as patch reefs. They range from 75 to 700 m (245-2300 ft) in diameter and from 7 to 14 m (23 to 46 ft) in height. The flat tops of these features are all at essentially the same depth of 66 m (216 ft), which was probably at the sea surface during their period of formation. The features in the 74- to 82-m (243- to 269-ft) depth range follow the shelf edge for a distance of over 70 km (43 mi). The taller reef-like mounds are the historical "pinnacles" for which the region is named. The pinnacles are up to 20 m (66 ft) in height and can be over 500 m (1,640 ft) in diameter (Thompson et al., 1999; Brooks, 1991). They extend laterally for over 28 km (17 mi) at the 105- to 120-m (345- to 394-ft) depth band. Some reef-like mounds also occur outside the two major depth bands. Several clusters are found shoreward in 60-70 m (197-230 ft) of water. To the west, two clusters are found at 87- to 94-m (285- to 308-ft) depths (Brooks, 1991).

The shape and configuration of these reef-like mounds is similar to tropical coral reef formations. Early investigators of this area in 1957 hypothesized that they are "drowned calcareous reefs not yet extinct" (Ludwick and Walton, 1957). More recent studies using dredges, grab samples, and imaging have confirmed this evaluation. Some of these are tall and steep-sided in profile. The taller mounds tend to have more complex shape with pits and overhangs in addition to flat tops and vertical sides (CSA, 2001).

Ridges and Scarps

Ridges are the largest features in the area. Linear ridges paralleling the isobaths are reported in various depths (Brooks, 1991; Thompson et al., 1999). These ridges are typically about 20 m (66 ft) wide (up to 250 m (820 ft)) and over 1 km (3,281 ft) long. Most of the ridges are low relief, around 1 m (3 ft) in height. Brooks found a ridge with scarps up to 8 m (66 ft) high in depths around 60 m (197 ft). They often occur in groups of 6-8 ridges together (Brooks, 1991). They appear to be biogenic features formed during periods of lower sea levels during the last deglaciation (Sager et al., 1992), possibly from lithified coastal dunes (Thompson et al., 1999).

Nepheloid Layer

A persistent nepheloid layer characterized by high turbidity was identified as a controlling factor for hard-bottom communities in the northwestern Gulf (Rezak et al., 1985). The nepheloid layer increases light attenuation, resulting in decreased epibiota and reef fish species richness and abundance below 80 m (262 ft) (Dennis and Bright, 1988; Rezak et al., 1990). Previous studies have suggested that the Mississippi River plume influences the distribution and abundance of sessile invertebrates within 70 km (43 mi) of the river delta and may produce a gradient of sedimentation and water-column turbidity throughout the Pinnacles Reef Tract (Gittings et al., 1992; CSA et al., 2001). In the northeastern Gulf, nepheloid layers are infrequent, though in conjunction with episodic Mississippi freshwater plumes and upwelling result in increased light attenuation (CSA et al., 2001).

Ecology

The pinnacle features provide a significant amount of hard substrate for colonization by suspension-feeding invertebrates and support relatively rich live bottom and fish communities. Assemblages of coralline algae, sponges, octocorals, crinoids, bryozoans, and fishes are present at the tops of the shallowest features in water depths of less than 70 m (230 ft). On the deeper features, as well as along the sides of these shallower pinnacles, ahermatypic corals may be locally abundant, along with octocorals, crinoids, and basket stars. The diversity and abundance of the associated species appear to be related to the size and complexity of the features, with the low-relief rock outcrops (<1 m (3 ft) height) typically having low faunal densities, and higher relief features having the more diverse faunal communities.

Substrate characteristics and turbidity seem to be the major factors determining the composition of communities at different locations and depth levels in the Pinnacle Trend. The biological communities on the Pinnacle Trend become more diverse toward the east and with greater distance from the Mississippi River. This is a matter of both substrate and turbidity. The Mississippi River brings a large load of fine silty sediment to the GOM. Although the majority of this turbidity is swept to the west by currents, it does affect the communities to the east. Sometimes the pattern is reversed with the majority swept to the east. Previous studies have suggested that the Mississippi River plume influences the distribution and abundance of sessile invertebrates within 70 km (43 mi) of the river delta and may produce a gradient of sedimentation and water-column turbidity throughout the Pinnacles Reef Tract (Gittings et al., 1992; CSA et al., 2001). In addition, a nepheloid layer (heavy-bottom turbidity layer), common in the western Gulf, sometimes affects the Pinnacle Trend (Weaver et al., 2001). The nepheloid layer increases light attenuation resulting in decreased epibiota and reef fish species richness and abundance below 80 m (262 ft) (Dennis and Bright, 1988; Rezak et al., 1990). Resuspension of sediments is a major contributor to turbidity in the Pinnacle Trend. This is more severe in the western part of the area because of the silty sediments deposited by the Mississippi River. Resuspension is caused by currents and wave action. Because of the depth of the bottom in the Pinnacle Trend area, waves seldom have a direct influence. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments. These forces are not expected to be strong enough to cause direct physical damage to organisms living on the reefs. Rather, currents are created by the wave action that can resuspend sediments to produce added turbidity and sedimentation. The animals in this region are well-adapted to the effects common to this frequently turbid environment. The end result of these factors is that communities closer to the Mississippi River are less diverse and communities near the bottom are less diverse.

The characteristics of the substrate have a high degree of control over the composition of the biological communities that live on it. The features of the Pinnacle Trend are composed of carbonate reef material. However, this comes in a variety of shapes and sizes as described above. The more complex the shape of the substrate, the greater the variety of habitats for organisms. Shallow depressions and low mounds harbor some organisms but the potential is limited. A pinnacle 20 m (66 ft) tall with slopes, cliffs, crevices, and overhangs may host the maximum number of species and a high density of animals. The bottom of a tall pinnacle will have very low diversity with mostly upright species present such as comatulid crinoids; the ahermatypic hard coral, *Rhizopsammia manuelensis*; black corals, *Antipathes* spp. and *Cirripathes* sp.; and the gorgonian, *Ellisella* sp. The roughtongue bass, *Pronotogrammus martinicensis*, is the dominant fish at the base of pinnacles (68.8% of the community). Other common fish near the bottom are the red barbier, *Hemanthias vivanus* (8.7%); cubbyu, *Pareques umbrosus* (5.8%); bigeye soldierfish, *Ostichthys trachpoma* (2.5%); and the wrasse bass, *Liopropoma eukrines* (2.0%) (Weaver et al., 2002).

Features tall enough to rise above the common effects of turbidity have higher community diversity and density. At least 34 different epibenthic species were found during one study of the shelf-edge features (CSA, 1992a). The walls were densely populated by *R. manuelensis* with frequent occurrence of *Antipathes* spp., *Cirripathes luetkeni*, and *Ellisella* sp. Some other ahermatypic stony corals were also seen, including *Madrepora carolina*, *Madracis myriaster*, *Oculina diffusa*, and a solitary cup coral, possibly *Balanophyllia floridana*. Comatulid crinoids were also observed. This zone was dominated by the roughtongue bass (48%) and red barbier (40%) (Weaver et al., 2002).

The crests of the pinnacles are perhaps slightly more diverse than the walls. The same dominant species were seen as on the walls with the common addition of the gorgonian coral, *Bebryce* sp. The density of dominant species is higher, with *R. manuelensis* very common. Coralline algae occur on hard substrates above about 78 m (256 ft) depth. To the east, the crests and walls of pinnacles are dominated by low-growing ahermatypic hard corals. Fish communities on pinnacle crests are dominated by the red barbier (59.7%); roughtongue bass (25.7%); Gobiidae (5.1%); greenband wrasse, *Halichoeres bathyphilus* (1.7%); and yellowtail reeffish, *Chromis enchrysura* (1.3%) (Weaver et al., 2002).

Horizontal surfaces have a considerably higher biological cover than vertical surfaces. This is likely because a greater number of individuals are able to settle and colonize a horizontal surface. Dominant species are similar to those on the walls of the pinnacles. However, some species not present on vertical surfaces are found on horizontal surfaces including several sponges (*Geodia neptuni*, *Cinachyrella* sp., and unidentified orange sponges) and a gorgonian coral, possibly *Nicella* sp. The tops of reefs with extensive flat summits are dominated by the taller gorgonian corals, as well as by sponges and crinoids. It is likely that sedimentation limits the colonization of low-growing species, such as many of the ahermatypic hard corals. Dominant fish species on the flat tops include the red barbier (58.8%), roughtongue bass (21.4%), gobies (5.6%), yellowtail reeffish (3.0%), and greenband wrasse (2.0%) (Weaver et al., 2002).

Diversity and density of epibenthic organisms varies considerably between features in the Pinnacle Trend area. The general trend is less turbidity and greater biological development toward the east. In addition, the sediment is less silty to the east. This results in an increase of diversity and density of organisms to the east. Other factors, some already mentioned, contribute to local differences in community structure. Areas with more exposed hard bottom, vertical relief, rugosity, and complexity of the substrate have higher biological diversity and density. The association of multiple features in proximity to one another makes an area more biologically diverse and promotes higher densities of organisms than an area with fewer, more scattered features. The Pinnacle Trend is a system of exposed hard substrates. Low-relief mounds occur in quite extensive groups. Patch reefs are particularly abundant in fields of as many as 35-70 features per hectare (14-28 features per acre). Flat top reefs all rise to the same depth along the shelf edge for over 70 km (44 mi). Tall pinnacles are clustered in depth bands and extend for over 28 km (17 mi). Ridge formations are often found with six or eight in sequence. The reefs are richer because they are in close proximity to each other. Even solitary, simple, low-relief mounds support low-diversity assemblages, which combine with major features to form a large reef tract. The Pinnacle Trend reef tract forms a major ecosystem with an influence that pervades the wider regional ecosystem.

3.2.2.1.2. Topographic Features

The shelf and shelf edge of the Western and Central Gulf are characterized by topographic features that are inhabited by hard-bottom benthic communities. The habitat created by the topographic features is important for the following reasons:

(1) they support hard-bottom communities of high biomass, high diversity, and high numbers of plant and animal species;

(2) they support, either as shelter or food, or both, large numbers of commercially and recreationally important fishes;

(3) they are unique to the extent that they are small, isolated areas of such communities in vast areas of much lower diversity;

(4) they provide a relatively pristine area suitable for scientific research (especially the East and West Flower Garden Banks); and

(5) they have an aesthetically intrinsic value.

Figure 3-5 depicts the location of 37 known topographic features in the GOM; 21 in the WPA and 16 in the CPA.

In 1998, USGS, in cooperation with MMS and the Flower Garden Banks National Marine Sanctuary, surveyed the East and West Flower Garden Banks using high-resolution, multi-beam mapping techniques (Gardner et.al, 1998). In 2002, they mapped 12 more topographic features, including Alderdice, Sonnier, Geyer, Bright, Rankin (1 and 2), Jakkula, McNeil, Bouma, McGrail, Rezak, and Sidner Banks (Gardner et al., 2002b). These surveys reveal complex bathymetry in some areas surrounding the banks outside the No Activity Zones. These small features surrounding the banks are considered important fish habitat and are protected by MMS from impacts of oil and gas activities.

Benthic organisms on these features are mainly limited by temperature and low light; extreme water temperature and light intensity are known to stress corals. Temperatures lower than 16 ^{o}C reduce coral growth, while temperatures in excess of 32 ^{o}C will impede coral growth and induce coral bleaching (loss of symbiotic zooxanthellae). While intertidal corals are adapted to high light intensity, most corals become stressed when exposed to unusually high light levels. Furthermore, although corals will grow or survive under low light level conditions, they do best submerged in clear, nutrient-poor waters. Light penetration in the Gulf is limited by several factors including depth and events of prolonged turbidity. Hard substrates favorable to colonization by coral communities in the northern Gulf are found on outer shelf, high-relief features. These substrates are found above the nepheloid layer, are off the muddy seafloor, and are bathed most of the year in nutrient-poor waters. The East and West Flower Garden Banks are examples of such suitable substrates. Average turbidity values at the Flower Garden Banks (<11 nephelometric units (NTU)) correspond to turbidity levels that do not affect the photosynthesis and respiration of corals (Precht et al., 2006). The depth of these banks reduces the effects of storms on the habitats. Whereas typical Caribbean shore reefs can suffer extensive damage from tropical storms, only the strongest storms reach down to reefs in the GOM. The most common influence of strong storms on these banks is an increase in turbidity, generally at the lower levels of the banks. Turbidity and sedimentation are normal in these lower levels because of the nepheloid layer and normal resuspension.

Severe hurricanes can cause physical damage to reef structure and organisms. In September 2005, Hurricane Rita passed over the northwestern GOM, affecting at least 18 topographic features. Preliminary assessments of the East Flower Garden Bank reveal numerous large coral heads (2 m) toppled, many smaller broken pieces, evidence of physical impacts to coral tissues, large sponges broken, fields of finger coral (*Madracis mirabilis*) broken down, and large scale shifting of sand patches. Heat stress before the storm, compounded by physical damage, produced bleaching and subsequent disease that may be the worst ever seen at the Flower Garden Banks. About 7 percent of the coral cover was bleached, the worst recorded since 1990 (5%) (Precht et al., in preparation). Up to 46 percent of all coral colonies were partly affected by bleaching (Schmahl, personal communication, 2006). Four months after the storm, about 2 percent of coral colonies were affected by disease (Schmahl, personal communication, 2006). The East Flower Garden Bank was about 95 km (60 mi) west of the storm track. Sixteen other banks were closer to the storm track than the Flower Garden Banks. Results of the storm at these other banks are as yet unknown. Other banks farther to the east may have been similarly affected by Hurricane Katrina (August 2005).

The banks of the GOM have been identified and classified into seven distinct biotic zones (**Table 3-3**) (modified/updated from Rezak and Bright, 1981; Rezak et al., 1983); however, none of the banks contain all seven zones. The zones are divided into the following four categories depending upon the degree of reef-building activity in each zone.

Zones of Major Reef Building and Primary Production

Diploria-Montastraea-Porites Zone

This zone is characterized by 18-20 hermatypic coral species and is found predominantly at the East and West Flower Garden Banks. The dominant species/groups of the zone in order of dominance are the *Montastraea annularis complex* (this group includes *M. franksii*, *M. faveolata*, and *M. annularis*), *Diploria strigosa*, *Porites asteroides,* and *Montastraea cavernosa* (Precht et al., in preparation). Coralline algae are abundant in areas, which adds substantial amounts of calcium carbonate to the substrate and serves to cement the reef together. In addition to the coralline algae, there is a considerable amount of bare reef rock, which fluctuates in percent cover with the appearance of a red-turf like algae, at both banks. Red turf algae (primarily Order Ceramiales) is the dominant algal group at the East and West Flower Garden Banks and has increased in percent cover substantially over the last several years. Dokken et al. (2003) reported algal percent cover at both banks was significantly greater during 1999 than 1998. Percent coral cover at both banks averaged over the past 5 years is 56.0 percent (Precht et al., 2006a and in preparation; Dokken et al., 2003).

Typical sport and commercial fish observed in this zone include various grouper species, amberjack, barracuda; red, gray, and vermillion snapper; cottonwick; and porgy. There is also a diverse group of tropical reef fish species found on these banks, including creole fish; queen, stoplight, red band, and princess parrot fish; rock beauty; blue tang, and the whitespotted filefish, just to name a few. There are over 175 tropical reef species that reside within the high-diversity zone at the Flower Garden Banks (Dennis and Bright, 1988; Pattengill, 1998). This high-diversity *Diploria/Montastraea/Porites* Zone is found only at the East and West Flower Garden Banks in water depths less than 36 m.

Madracis and Fleshy Algal Zone

The *Madracis* Zone is dominated by the small branching coral *Madracis mirabilis*, which produces large amounts of carbonate sediment. In places, large (possibly ephemeral) populations of turf-like algae dominate the *Madracis* gravel substratum (Algal Zone). The *Madracis* Zone appears to have a successional relationship with the *Diploria-Montastraea-Porites* Zone. *Madracis* colony rubble builds up the substrate and allows the successional species to grow. The zone occurs at the East and West Flower Garden Banks on peripheral components of the main reefal structure between 28 and 46 m.

Stephanocoenia-Millepora Zone

The *Stephanocoenia-Millepora* Zone is inhabited by a low-diversity coral assemblage of 12 hermatypic corals and can be found at the Flower Garden, McGrail, and Bright Banks. The eight most conspicuous corals in order of dominance are *Stephanocoenia michelinii, Millepora alcicornis*, *Montastraea cavernosa*, *Colpophyllia natans*, *Diploria strigosa*, *Agaricia agaricites*, *Mussa angulosa*, and *Scolymia cubensis*. The assemblages associated with this zone are not well known; coralline algae are the most conspicuous organism in the zone. Additionally, reef fish populations are less diverse; but the Atlantic spiny oyster (*Spondylus americanus*) appears numerous. The depth range of this zone is between 36 and 52 m.

Algal-Sponge Zone

The Algal-Sponge Zone covers the largest area among the reef-building zones. The dominant organisms of the zone are the coralline algae, which are the most important carbonate producers. The algae produce nodules called "rhodoliths," which are composed of over 50 percent coralline algae, and form large beds on the seafloor. The rhodoliths range from 1 to 10 cm (0.4 to 4 in) in size, cover 50-80 percent of the bottom, and generally occur between 55 and 85 m. The habitat created by the alga nodules supports communities that are probably as diverse as the coral-reef communities. Most of the leafy algae found on the banks occur in this zone and contribute large amounts of food to the surrounding communities. Calcareous green algae (*Halimeda* and *Udotea)* and several species of hermatypic corals are major contributors to the substrate. Deepwater alcyonarians are abundant in the lower Algal-Sponge Zone. Sponges, especially *Neofibularia nolitangere,* are conspicuous. Echinoderms are abundant and also add to the carbonate substrate. Small gastropods and pelecypods are abundant. Gastropod shells are known to form the center of some of the algal nodules. Characteristic fish of the zone are yellowtail reef fish, sand tilefish, cherubfish, and orangeback bass.

Partly drowned reefs are a major biotope of the Algal-Sponge Zone. They are defined as those reefal structures covered with living crusts of coralline algae with occasional boulders of hermatypic corals. In addition to the organisms typical to the rest of the Algal-Sponge Zone, the partly drowned reefs are also inhabited by large anemones, large comatulid crinoids, basket stars, limited crusts of *Millepora*, and infrequent small colonies of other hermatypic species. The relief and habitat provided by the carbonate structures also attract a variety of fish species, especially yellow tail reef fish and blue and queen angelfish.

Zone of Minor Reef Building

Millepora-Sponge Zone

The *Millepora*-Sponge Zone occupies depths comparable to the *Diploria-Montastraea-Porites* Zone on the claystone-siltstone substrate of the Texas-Louisiana midshelf banks. One shelf-edge carbonate bank, Geyer Bank, also exhibits the zone but only on a bedrock prominence. Crusts of the hydrozoan coral, *Millepora alcicornis*, sponges, and other epifauna occupy the tops of siltstone, claystone, or sandstone outcrops in this zone. Scleractinian corals and coralline algae are rarely observed, largely due to seasonal temperatures that drop below the 18^{o}C minimum requirement for vigorous coral reef growth.

Transitional Zone of Minor to Negligible Reef Building

Antipatharian Zone

This transitional zone is not distinct but blends in with the lower Algal-Sponge Zone. It is characterized by an abundance of antipatharian whips growing with the algal-sponge assemblage. With increased water depth, the assemblages of the zone become less diverse, characterized by antipatharians, comatulid crinoids, few leafy or coralline algae, and limited fish (yellowtail redfish, queen angelfish, blue angelfish, and spotfin hogfish). Again, the depth of this zone differs at the various banks but generally extends to 90 m.

Zone of No Reef Building

Nepheloid Zone

High turbidity, sedimentation, and resuspension occur in this zone. Rocks or drowned reefs are covered with a thin veneer of sediment and epifauna are scarce. The most noticeable are comatulid crinoids, octocoral whips and fans, antipatharians, encrusting sponges, and solitary ahermatypic corals. The fish fauna is different and less diverse than those of the coral reefs or partly drowned reefs. These fish species include red snapper, spanish flag, snowy grouper, bank butterflyfish, scorpionfishes, and roughtongue bass. This zone occurs on all banks, but its depth differs at each bank. Generally, the Nepheloid Zone begins at the limit of the Antipatharian Zone and extends to the surrounding soft bottom.

Banks of the GOM

Shelf-Edge Banks		Midshelf Banks		South Texas Banks
Western	Central	Western	Central	Western Only
Appelbaum Bank East Flower Garden Bank MacNeil Bank Rankin Bank West Flower Garden Bank	Alderdice Bank Bouma Bank Bright Bank Diaphus Bank Elvers Bank Ewing Bank Geyer Bank Jakkula Bank McGrail Bank Parker Bank Rezak Bank Sidner Bank Sweet Bank	29 Fathom Bank 32 Fathom Bank Claypile Lump Coffee Lump Stetson Bank	Fishnet Bank Sackett Bank Sonnier Bank	Aransas Bank Baker Bank Big Dunn Bar Blackfish Ridge Dream Bank Hospital Bank Mysterious Bank North Hospital Bank Small Dunn Bar South Baker Bank Southern Bank

Figures 3-6 and 3-7 illustrate the topographic relief associated with several of the more developed features, i.e., the East and West Flower Garden Banks and Stetson Bank.

Shelf-Edge Banks

The shelf-edge banks of the Western and Central Gulf generally exhibit the *Diploria-Montastraea-Porites* zonation that is exhibited at the East and West Flower Garden Banks at comparable depths. However, Geyer Bank (37-m (121-ft) crest), which is within the depth of the high-diversity, coral-reef zone, does not exhibit the high-diversity characteristics. Instead, Geyer Bank has a well-developed *Millepora*-Sponge Zone, which is typically the defining characteristic of midshelf banks found elsewhere in the GOM.

Midshelf Banks

Five midshelf banks contain the *Millepora*-Sponge Zone: Sonnier and Fishnet Banks in the Central Gulf; and Stetson, Claypile, and 29 Fathom Banks in the Western Gulf. The nepheloid layer often enfolds Claypile Bank, considered a low-relief bank with only 10 m (33 ft) of relief. Therefore, the level of development of the *Millepora*-Sponge community is lowest at Claypile Bank. Two other midshelf banks in the Western Gulf (32 Fathom Bank and Coffee Lump) are also low-relief banks with less than 10 m (33 ft) of relief.

Stetson Bank is isolated from other banks and lies near the northern physiological limit for the advanced development of reef-building hermatypic corals. The species composition is markedly different from that of other tropical reefs including the Flower Garden Banks. However, in addition to the *Millepora*-Sponge characteristics at Stetson Bank, there are sparsely distributed reef- and non reef-building coral species found. *Madracis decactus*, *Agaricia fragilis*, (ahermatypic corals), *Stephenocoenia michelinii*, and *Diploria strigosa* (hermatypic corals) are coral species found at Stetson Bank in scattered patches. In addition to Stetson's unique landscape and topographic features (**Figure 3-7**), there is an abundance of marine life residing at the bank. Over 140 species of reef and schooling fishes, 108 mollusks, and 3 predominant echinoderms are reported. Due to its vertical orientation, Stetson attracts a number of pelagic species that move back and forth across the continental shelf utilizing various banks, including the Flower Gardens, for seasonal feeding, mating, and as nursery grounds. These large pelagic animals include species such as manta and devil rays and the filter-feeding whale shark.

Figure 3-8 shows the 1-Mile and 3-Mile Zones around Sonnier Bank as examples of the protective zonation that would be established by the Topographic Features Stipulation proposed for these proposed lease sales.

South Texas Banks

The South Texas banks are geographically/geologically distinct from the shelf-edge banks. Several of the South Texas banks are also low-relief banks. These banks exhibit a reduced biota and have relatively low relief, few hard-substrate outcrops, and a thicker sediment cover than the other banks.

It has been suggested that four other South Texas features in the Western Gulf be considered as sensitive offshore topographic features: Phleger, Sebree, and Big and Small Adam Banks. Phleger Bank (a shelf-edge bank) crests at 122 m, deeper than the lower limit of the No Activity Zones (85 m (279 ft)[100 m (328 ft) in the case of the Flower Gardens]). The depth of the bank precludes the establishment of the Antipatharian Zone so that even though the bank is in clear water, the biota is typical of the nepheloid zone. The bank appears to be predominantly covered with sand, with scattered rock outcrops of approximately 1-2 m (3-7 ft) in diameter and 1 m (3ft) in height. The sand substrate is devoid of sessile benthic organisms, although the rock outcrops support a number of epifaunal species such as cup-shaped and encrusting sponges, octocorals, and crinoids. Roughtongue bass were observed in video surveys to be the dominant fish species on this bank.

Sebree Bank, located in 36.5 m (120 ft) of water, is a low-relief feature of approximately 3 m (10 ft) in relief and is located in an area subject to high sedimentation. Clusters of the scleractinian coral, *Oculina diffusa*, have been observed on the rocky outcrops of this bank. This species tends to thrive in habitats exhibiting low light and high sedimentation. In the GOM, it forms branched, low-relief, generally round colonies, and does not create reefs or distinctive assemblages of reefal species. The bank attracts abundant nektonic species, including red snapper and other commercially and recreationally important finfish (Tunnell, 1981). Findings in the August 1993 cooperative dive effort on Sebree Bank by MMS, the State of Texas, and Texas A&M University at Corpus Christi (Dokken et al., 1993) were generally consistent with those reported by Tunnell (1981).

Dokken et al. (1993) compared the nepheloid dominated, low-diversity community of Sebree Bank with the nepheloid zone community described by Rezak et al. (1985). Rezak and Bright (1981) devised an environmental priority index to rate the sensitivity of topographic features in the northern GOM:

A. South Texas midshelf relict Pleistocene carbonate reefs bearing turbidity tolerant Antipatharian Zone and Nepheloid Zone (surrounding depths of 60-80 m (197-262 ft), crests 56-70 m (184-230 ft)).

B. North Texas-Louisiana midshelf, Tertiary-outcrop banks bearing clear-water, *Millepora*-Sponge Zone and turbid-water-tolerant Nepheloid Zone (surrounding depths of 50-62 m (164-203 ft), crests 18-40 m (59-131 ft).

C. North Texas-Louisiana midshelf banks bearing turbidity-tolerant assemblages approximating the Antipatharian Zone (surrounding depths of 65-78 m (213-256 ft), crests 52-66 m (171-216 ft)).

D. North Texas-Louisiana shelf-edge, carbonate banks bearing clear-water coral reefs and Algal-Sponge Zones, transitional assemblages approximating the Antipatharian Zone and Nepheloid Zone (surrounding depths of 84-200 m (276-656 ft), crests 15-75 m (49-246 ft)).

E. Eastern Louisiana shelf-edge, carbonate banks bearing poorly developed elements of the Algal-Sponge Zone, transitional Antipatharian Zone assemblages, and Nepheloid Zone (surrounding depths of 100-110 m (328-361 ft), crests 67-73 m (220-240 ft).

They categorized similar features containing nepheloid zone communities as Class D banks, where protection is not recommended. Since Sebree Bank is located within a shipping fairway, it is relatively well protected from physical impacts (anchoring or drilling disturbance). While they did not specifically discuss Sebree Bank, based on five ranking criteria, similar nepheloid zone communities were given the lowest rating of all the topographic features.

Big and Small Adam Banks are also low-relief features subject to sedimentation. Rezak and Bright (1981) categorized these features as Class D banks, where protection is not recommended. Although the banks may contain the Antipatharian Zone, this designation is speculative (Rezak et al., 1983). Big and

Small Adam Banks were given the lowest ratings of those topographic features discussed by Rezak and Bright (1981), based on their criterion for environmental priority rankings.

3.2.2.2. Continental Slope and Deepwater Resources

The northern GOM is a geologically complex basin. It has been described as the most complex continental slope region in the world. Regional topography of the slope consists of basins, knolls, ridges, and mounds derived from the dynamic adjustments of salt to the introduction of large volumes of sediment over long time scales. This region has become much better known in the last three decades, and the existing information is considerable, both from a geological and biological perspective. The first substantial collections of deep GOM benthos were made during the cruises of the U.S. Coast and Geodetic Steamer, *Blake*, between 1877 and 1880. Rowe and Menzel (1971) reported that their deep GOM infauna data was the first quantitative data published for this region. The first major study of the deep northern GOM was performed by a variety of researchers from Texas A&M University between 1964 and 1973 (Pequegnat, 1983). A total of 157 stations were sampled and photographed between depths of 300 and 3,800 m (984 and 12,467 ft) (the deepest part of the GOM). A more recent study funded by MMS was completed by LGL Ecological Research Associates and Texas A&M University in 1988, during which a total of 60 slope stations were sampled throughout the northern GOM in water depths between 300 and 3,000 m (9,842 ft) (Gallaway et al., 1988). As part of this multiyear study, along with trawls and quantitative box-core samples, 48,000 photographic images were collected and a large subset was quantitatively analyzed. Another major study, titled *Northern Gulf of Mexico Continental Slope and Benthic Ecology*, will be completed at the time of publication of this Final EIS. This six-year project spanned three field sampling years and included collections of benthos and/or sediments through trawling, box coring and bottom photography at a total of 51 stations ranging in depth from 213 to 3,732 m (699 to 12,244 ft), including some stations in Mexican waters (Rowe and Kennicutt, in prepartion).

The continental slope is a transitional environment influenced by processes of both the shelf and the abyssal (deep sea) GOM (>975 m). This transitional character applies to both the pelagic and the benthic realms. The highest values of surface primary production are found in the upwelling areas in the DeSoto Canyon region. In general, the Eastern GOM is more productive in the oceanic region than is the Western GOM. It is generally assumed that all the phytoplankton is consumed by the zooplankton, except for brief periods during major plankton blooms. The zooplankton then egests a high percentage of their food intake as feces that sink toward the bottom.

The general fauna, including macrofauna and fishes, when considered together, have been shown to group into major assemblages defined by depth including (1) upper slope, (2) mid-slope, (3) lower slope, and (4) abyssal plain (Rowe and Kennicutt, in prepartion). The 450-m (1,476-ft) isobath defines the truly deep-sea fauna where the aphotic zone begins at and beyond these depths. In these sunlight-deprived waters, photosynthesis cannot occur and processes of food consumption, biological decomposition, and nutrient regeneration occur in cold and dark waters. The lowermost layer containing the last meter of water off the bottom and the bottom itself constitutes the benthic zone. This zone is a repository of sediments where nutrient storage and regeneration take place in association with the solid and semisolid substrate (Pequegnat, 1983). The seven zones previously described by Pequegnat (1983) and confirmed by LGL Ecological Research Associates, Inc. and Texas A&M University (Gallaway et al., 1988) now appear to be too numerous. Similar to the continental slope in general, the proposed lease sale areas encompass a vast range of habitats and water depths. The shallowest lease areas encompass the entirety of the upper slope, regardless of the depth criteria used to define the continental slope. The deepest portions extend nearly into the deepest part of the GOM at approximately 3,500 m (11,483 ft) south of the Sigsbee Escarpment in the Central Gulf. This is not particularly deep for the rest of the world's oceans, but it is within a few hundred meters of the deepest point of the GOM at 3,840 m (12,598 ft), only accessible from Mexican waters of the southern Gulf. The proposed lease sale area also includes the lower portions of DeSoto Canyon. This trough is the most notable sea-bottom feature on the upper slope in this area. Its formation has been attributed to a combination of erosion, deposition, and structural control of salt diapirs clustered in the vicinity (Harbison, 1968). Although the northeastern edge of the canyon has a steep slope, unlike most submarine canyons, DeSoto Canyon has a comparatively gentle gradient; however, it does have significant impact on current structure, upwelling features, and resulting increases in biological productivity.

A great number of publications have derived from the two major MMS-funded deep Gulf studies of Rowe and Kennicutt (in preparation) and Gallaway et al. (1988). These two studies are incorporated by reference for extensive background information on deepwater GOM habitat and biological communities.

3.2.2.2.1. Chemosynthetic Communities

Chemosynthetic communities are remarkable in that they utilize a carbon source independent of photosynthesis and the sun-dependent photosynthetic food chain that supports all other life on earth. Although the process of chemosynthesis is entirely microbial, chemosynthetic bacteria and their production can support thriving assemblages of higher organisms through symbiosis. The chemosynthetic communities of the GOM have been studied extensively over the past 20 years, and communities first discovered on the upper slope are likely the best understood seep communities in the world. The history of discovery of these remarkable animals has all occurred within only the last 30 years. Interestingly, each major discovery was unexpected―from the first hydrothermal vent communities anywhere in the world to the first, cold seep communities in the GOM. The first discovery of any deep-sea chemosynthetic community including higher animals was unexpectedly made at hydrothermal vents in the eastern Pacific Ocean during geological explorations (Corliss et al., 1979). Two scientists, J. Corliss and J. van Andel, first witnessed dense chemosynthetic clam beds from the submersible *Alvin* on February 17, 1977, after their unanticipated discovery using a remote camera sled two days before. Similar communities were first discovered in the Eastern GOM in 1983 on another *Alvin* cruise investigating the bottom of the Florida Escarpment in areas of "cold" brine seepage where they unexpectedly discovered tubeworms and mussels (Paull et al., 1984).

Two groups fortuitously discovered chemosynthetic communities in the Central GOM concurrently in November 1984. During investigations by Texas A&M University to determine the effects of oil seepage on benthic ecology (until this investigation, all effects of oil seepage were assumed to be detrimental), bottom trawls unexpectedly recovered extensive collections of chemosynthetic organisms including tube worms and clams (Kennicutt et al., 1985). At the same time, LGL Ecological Research Associates was conducting a research cruise as part of the multiyear MMS Northern Gulf of Mexico Continental Slope Study (Gallaway et al., 1988). Bottom photography (processed on board the vessel) resulted in clear images of vesicomyid clam chemosynthetic communities coincidentally in the same manner as the first discovery by camera sled in the Pacific in 1977. Photography during the same LGL/MMS cruise also documented tube-worm communities *in situ* in the Central GOM for the first time (not processed until after the cruise; Boland, 1986) prior to the initial submersible investigations and firsthand descriptions of Bush Hill in 1986 (Rosman et al., 1987a; MacDonald et al., 1989b). The site was targeted by acoustic "wipeout" zones or lack of substrate structure caused by seeping hydrocarbons. This was determined using an acoustic pinger system during the same cruise on the R/V *Edwin Link* (the old one, only 113 ft (34 m)), which used one of the *Johnson Sea Link* submersibles. The site is characterized by dense tubeworm and mussel accumulations as well as exposed carbonate outcrops with numerous gorgonian and *Lophelia* coral colonies. Bush Hill has become one of the most thoroughly studied chemosynthetic sites in the world.

Distribution

There is a clear relationship between known hydrocarbon discoveries at great depth in the Gulf slope and chemosynthetic communities, hydrocarbon seepage, and authigenic minerals including carbonates at the seafloor (Sassen et al., 1993a and b). While the hydrocarbon reservoirs are broad areas several kilometers beneath the Gulf, chemosynthetic communities occur in isolated areas with thin veneers of sediment only a few meters thick.

The northern GOM slope includes a stratigraphic section more than 10 km (6 mi) thick and has been profoundly influenced by salt movement. Mesozoic source rocks from Upper Jurassic to Upper Cretaceous generate oil in most of the Gulf slope fields (Sassen et al., 1993a and b). Migration conduits supply fresh hydrocarbon materials through a vertical scale of 6-8 km (4-5 mi) toward the surface. The surface expressions of hydrocarbon migration are referred to as seeps. Geological evidence demonstrates that hydrocarbon and brine seepage persists in spatially discrete areas for thousands of years. The time scale for oil and gas migration (combination of buoyancy and pressure) from source systems is on the scale of millions of years (Sassen, 1997). Seepage from hydrocarbon sources through faults towards the surface tends to be diffused through the overlying sediment, carbonate outcroppings, and hydrate deposits so the corresponding hydrocarbon seep communities tend to be larger (a few hundred meters wide) than chemosynthetic communities found around the hydrothermal vents of the Eastern Pacific (MacDonald, 1992). There are large differences in the concentrations of hydrocarbons at seep sites. Roberts (2001) presented a spectrum of responses to be expected under a variety of flux rate conditions varying from very slow seepage to rapid venting. Very slow seepage sites do not support complex chemosynthetic communities; rather, they usually only support simple microbial mats (*Beggiatoa sp.*). In the upper slope environment, the hard substrates resulting from carbonate precipitation can have associated communities of nonchemosynthetic animals, including a variety of sessile cnidarians such as corals and anemones. At the rapid flux end of the spectrum fluidized sediment generally accompanies hydrocarbons and formation fluids arriving at the seafloor. Mud volcanoes and mud flows result. Somewhere between these two end members exists the conditions that support densely populated and diverse communities of chemosynthetic organisms (microbial mats, siboglinid tube worms, bathymodioline mussels, lucinid and vesycomyid clams, and associated organisms). These areas are frequently associated with surface or near-surface gas hydrate deposits. They also have localized areas of lithified seafloor, generally authigenic carbonates but sometimes more exotic minerals such as barite are present.

The widespread nature of GOM chemosynthetic communities was first documented during contracted investigations by the Geological and Environmental Research Group (GERG) of Texas A&M University for the Offshore Operators Committee (Brooks et al., 1986). This survey remains the most widespread and comprehensive, although numerous additional communities have been documented since that time. Industry exploring for energy reserves in the Gulf has also documented numerous new communities through a wide range of depths, including the deepest known occurrence in the Central GOM in Alaminos Canyon Block 818 at a depth of 2,750 m (9,022 ft). The occurrence of chemosynthetic organisms dependent on hydrocarbon seepage has been documented in water depths as shallow as 290 m (951 ft) (Roberts et al., 1990) and as deep as 2,744 m (9,003 ft) (Allen, personal communication, 2005). This depth range specifically places chemosynthetic communities in the deepwater region of the GOM, which is defined as water depths greater than 305 m (1,000 ft). Chemosynthetic communities are not found on the continental shelf although they do appear in the fossil record in water shallower than 200 m (656 ft). One theory explaining this is that predation pressure has varied substantially over the time period involved (Callender and Powell 1999). More than 50 communities are now known to exist in 43 OCS blocks (Fi**gure 3-9**). Although a systematic survey has not been done to identify all chemosynthetic communities in the Gulf, there is evidence indicating that many more such communities may exist. The depth limits of discoveries probably reflect the limits of exploration (lack of submersibles capable of depths over 1,000 m (3,281 ft)). MacDonald et al. (1993 and 1996) have analyzed remote-sensing images from space that reveal the presence of oil slicks across the north-central GOM. Results confirmed extensive natural oil seepage in the Gulf, especially in water depths greater than 1,000 m (3,281 ft). A total of 58 additional potential locations were documented where seafloor sources were capable of producing perennial oil slicks (MacDonald et al., 1996). Estimated seepage rates ranged from 4 to 70 bbl/day compared to less than 0.1 bbl/day for ship discharges (both normalized for 1,000 mi^2 (640,000 ac)). This evidence considerably increases the area where chemosynthetic communities dependent on hydrocarbon seepage may be expected.

The densest aggregations of chemosynthetic organisms have been found at water depths of around 500 m (1,640 ft) and deeper. The best known of these communities was named Bush Hill by the investigators who first described it (MacDonald et al., 1989b). It is a surprisingly large and dense community of chemosynthetic tube worms and mussels at a site of natural petroleum and gas seepage over a salt diapir in Green Canyon Block 185. The seep site is a small knoll that rises about 40 m (131 ft) above the surrounding seafloor in about 580-m (1,903-ft) water depth.

Stability

According to Sassen (1997) the role of hydrates at chemosynthetic communities has been greatly underestimated. The biological alteration of frozen gas hydrates was first discovered during the MMS study "Stability and Change in Gulf of Mexico Chemosynthetic Communities." It is hypothesized (MacDonald, 1998b) that the dynamics of hydrate alteration could play a major role as a mechanism for regulation of the release of hydrocarbon gases to fuel biogeochemical processes and could also play a substantial role in community stability. Recorded bottom-water temperature excursions of several degrees in some areas such as the Bush Hill site (4-5 °C at 500-m (1,640-ft) depth) are believed to result in dissociation of hydrates, resulting in an increase in gas fluxes (MacDonald et al., 1994). Although not as destructive as the volcanism at vent sites of the mid-ocean ridges, the dynamics of shallow hydrate formation and movement will clearly affect sessile animals that form part of the seepage barrier. There is potential of a catastrophic event where an entire layer of shallow hydrate could break free of the bottom and result in considerable impact to local communities of chemosynthetic fauna. At deeper depths (>1,000 m, >3,281 ft), the bottom-water temperature is colder (by approximately 3 °C) and undergoes less fluctuation. The formation of more stable and probably deeper hydrates influences the flux of light hydrocarbon gases to the sediment surface, thus influencing the surface morphology and characteristics of chemosynthetic communities. Within complex communities such as Bush Hill, oil seems less important than previously thought (MacDonald, 1998b).

Through taphonomic studies (death assemblages of shells) and interpretation of seep assemblage composition from cores, Powell et al. (1998) reported that, overall, seep communities were persistent over periods of 500-1,000 years and probably throughout the entire Pleistocene. Some sites retained optimal habitat over geological time scales. Powell reported evidence of mussel and clam communities persisting in the same sites for 500-4,000 years. Powell also found that both the composition of species and trophic tiering of hydrocarbon seep communities tend to be fairly constant across time, with temporal variations only in numerical abundance. He found few cases in which the community type changed (from mussel to clam communities, for example) or had disappeared completely. Faunal succession was not observed. Surprisingly, when recovery occurred after a past destructive event, the same chemosynthetic species reoccupied a site. There was little evidence of catastrophic burial events, but two instances were found in mussel communities in Green Canyon Block 234. The most notable observation reported by Powell (1995) was the uniqueness of each chemosynthetic community site.

Precipitation of authigenic carbonates and other geologic events will undoubtedly alter surface seepage patterns over periods of many years, although through direct observation, no changes in chemosynthetic fauna distribution or composition were observed at seven separate study sites (MacDonald et al., 1995). A slightly longer period (19 years) can be referenced in the case of Bush Hill, the first Central Gulf community described *in situ* in 1986. No mass die-offs or large-scale shifts in faunal composition have been observed (with the exception of collections for scientific purposes) over the 19-year history of research at this site.

All chemosynthetic communities are located in water depths beyond the impact of severe storms, including hurricanes, and there would have been no alteration of these communities caused from surface storms, including the severe hurricane season of 2005.

Biology

MacDonald et al. (1990) has described four general community types. These are communities dominated by Vestimentiferan tube worms (*Lamellibrachia c.f. barhami* and *Escarpia* n.sp.), mytilid mussels (Seep Mytilid Ia, Ib, and III, and others), vesicomyid clams (*Vesicomya cordata* and *Calyptogena ponderosa*), and infaunal lucinid or thyasirid clams (*Lucinoma* sp. or *Thyasira* sp.). Bacterial mats are present at all sites visited to date. These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them. Many of the species found at these cold seep communities in the Gulf are new to science and remain undescribed.

Individual lamellibranchid tube worms, the longer of two taxa found at seeps can reach lengths of 3 m (10 ft) and live hundreds of years (Fisher et al., 1997; Bergquist et al., 2000). Growth rates determined from recovered marked tube worms have been variable, ranging from no growth of 13 individuals measured one year to a maximum growth of 9.6 cm/yr (3.8 in/yr) in a *Lamellibrachia* individual (MacDonald, 2002). Average growth rate was 2.19 cm/yr (0.86 in/yr) for the *Escarpia*-like species and 2.92 cm/yr (1.15 in/yr) for lamellibrachids. These are slower growth rates than those of their hydrothermal vent relatives, but *Lamellibrachia* individuals can reach lengths 2-3 times that of the largest known hydrothermal vent species. Individuals of *Lamellibrachia* sp. in excess of 3 m (10 ft) have been collected on several occasions, representing probable ages in excess of 400 years (Fisher, 1995). Vestimentiferan tube worm spawning is not seasonal and recruitment is episodic.

Tubeworms are either male or female. One recent discovery indicates that spawning of female *Lamellibrachia* appears to result in the unique association of the large bivalve *Acesta bullisi* living permanently attached the anterior tube opening of the tubeworm feeding on the periodic egg release (Järnegren et al., 2005). This close association between the bivalves and tubeworms was discovered in 1984 (Boland, 1986) but not fully explained. Virtually all mature *Acesta* individuals are found on female rather than male tubeworms. This evidence and other experiments by Järnegren et al. (2005) seem to have solved this mystery.

Growth rates for methanotrophic mussels at cold seep sites have been reported (Fisher, 1995). General growth rates were found to be relatively high. Adult mussel growth rates were similar to mussels from a littoral environment at similar temperatures. Fisher also found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults; they grow to reproductive size very quickly. Both individuals and communities appear to be very long lived. These methane-dependent mussels have strict chemical requirements that tie them to areas of the most active seepage in the GOM. As a result of their rapid growth rates, mussel recolonization of a disturbed seep site could occur relatively rapidly. There is some evidence that mussels also have some requirement of a hard substrate and could increase in numbers if suitable substrate is increased on the seafloor (Fisher, 1995). Two associated species are always found associated with mussel beds – the gastropod *Bathynerita naticoides* and a small Alvinocarid shrimp – suggesting these endemic species have excellent dispersal abilities and can tolerate a wide range of conditions (MacDonald, 2002).

Unlike mussel beds, chemosynthetic clam beds may persist as a visual surface phenomenon for an extended period without input of new living individuals because of low dissolution rates and low sedimentation rates. Most clam beds investigated by Powell (1995) were inactive. Living individuals were rarely encountered. Powell reported that over a 50-year timespan, local extinctions and recolonization should be gradual and exceedingly rare. Contrasting these inactive beds, the first community discovered in the Central Gulf consisted of numerous actively plowing clams. The images obtained of this community were used to develop length/frequency and live/dead ratios as well as spatial patters (Rosman et al., 1987a).

Extensive mats of free-living bacteria are also evident at all hydrocarbon seep sites. These bacteria may compete with the major fauna for sulfide and methane energy sources and may also contribute substantially to overall production (MacDonald, 1998b). The white, nonpigmented mats were found to be an autotrophic sulfur bacteria *Beggiatoa* species, and the orange mats possessed an unidentified nonchemosynthetic metabolism (MacDonald, 1998b).

Heterotrophic species at seep sites are a mixture of species unique to seeps (particularly molluscs and crustacean invertebrates) and those that are a normal component from the surrounding environment. Carney (1993) first reported a potential imbalance that could occur as a result of chronic disruption. Because of sporadic recruitment patterns, predators could gain an advantage, resulting in exterminations in local populations of mussel beds. It is clear that seep systems do interact with the background fauna but conflicting evidence remains as to what degree outright predation on some specific community components such as tubeworms occurs (MacDonald, 2002). The more surprising results from this recent work is why background species do not utilize seep production more that seems to be evident. In fact, seep-associated consumers such as galatheid crabs and nerite gastropods had isotopic signatures, indicating that their diets were a mixture of seep and background production. At some sites, endemic seep invertebrates that would have been expected to obtain much if not all their diet from seep production actually consumed as much as 50 percent of their diets from the background.

Detection

With continuing experience, particularly on the upper continental slope, the successful prediction of the presence of tubeworm communities continues to improve, however chemosynthetic communities cannot be reliably detected directly using geophysical techniques. Hydrocarbon seeps that allow chemosynthetic communities to exist do modify the geological characteristics in ways that can be remotely detected, but the time scales of co-occurring active seepage and the presence of living communities is always uncertain. These known sediment modifications include (1) precipitation of authigenic carbonate in the form of micronodules, nodules, or rock masses; (2) formation of gas hydrates; (3) modification of sediment composition through concentration of hard chemosynthetic organism remains (such as shell fragments and layers); (4) formation of interstitial gas bubbles or hydrocarbons; and (5) formation of depressions or pockmarks by gas expulsion. These features give rise to acoustic effects such as wipeout zones (no echoes), hard bottoms (strongly reflective echoes), bright spots (reflection enhanced layers), or reverberant layers (Behrens, 1988; Roberts and Neurauter, 1990). "Potential" locations for most types of communities can be determined by careful interpretation of these various geophysical modifications, but to date, the process remains imperfect and confirmation of living communities requires direct visual techniques.

3.2.2.2.2. Nonchemosynthetic Communities

Description

More than chemosynthetic communities are found on the bottom of the deep GOM. In contrast to early theories of the deep sea, animal diversity, particularly the smaller forms living in bottom sediments, rivals that of the richest terrestrial environments such as rain forests. Other types of communities include the full spectrum of living organisms also found on the continental shelf or other areas of the marine environment. Major groups include bacteria and other microbenthos, meiofauna (0.063-0.3 mm), macrofauna (<0.3 mm), and megafauna (larger organisms such as crabs, sea pens, crinoids, and demersal fish). All of these groups are represented throughout the entire GOM—from the continental shelf to the deepest abyss at about 3,850 m (12,630 ft). Recent study results in Rowe and Kennicutt (in prepartion) have indicated some unique areas near the Mississippi River Delta with substantially higher community biomass and carbon flux. Other areas of enhanced densities of nonchemosynthetic communities have also been reported in association with chemosynthetic communities (Carney, 1993). Some of these heterotrophic communities found at and near seep sites are a mixture of species unique to seeps and those that are a normal component from the surrounding environment.

There are also relatively rare examples of deepwater communities that would not be expected considering the fact that the vast majority of the deep GOM continental slope is made up of soft silt and clay sediments. Deepwater coral communities are now known to occur in numerous locations in the deep GOM; one example is represented by what was reported as a deepwater coral reef by Moore and Bullis (1960). In an area measuring 300 m (984 ft) in length and more than 20 nmi from the nearest known chemosynthetic community (Viosca Knoll Block 826), a trawl collection from a depth of 421-512 m (1,381-1,680 ft) retrieved more than 300 pounds of the scleractinian coral *Lophelia prolifera*. A large coral (*L. pertusa)* community was discovered in lease block Viosca Knoll 826 at a depth of 434 m (1,424 ft) by LGL Ecological Research Associates while doing a chemosynthetic community environmental survey for Oryx Energy in 1990 (LGL, 1990). Individual coral colonies at this site attain 1.5-2 m (5-7 ft) in height and width and up to 3-4 m (10-13 ft) in length. A large portion of the coral colonies are living. It was subsequently studied by submersible in the following years 1991 and 1992 as well as numerous occasions since and is described in detail in Schroeder (2002). These deepwater coral habitats have since been shown to be much more extensive and important to the support of diverse communities of associated fauna than previously known in the GOM. This community in Viosca Knoll Block 826 remains the largest and best developed *Lophelia* community known in the northern GOM. This type of unusual and unexpected community may exist in many other areas of the deep GOM. Although *Lophelia* is best represented in water depths of the upper slope, it has been reported as deep as 3,000 m (9,842 ft) in some parts of the world. Additional studies funded by MMS are in progress or in earlier stages of development that will further investigate the distribution of deepwater corals and other important nonchemosynthetic communities in the deep GOM.

Considering the depth of this resource, >400 m (1,312 ft), these deepwater communities would similarly be beyond the impacts from severe storms or hurricanes, and there has been no alteration of these communities caused from surface storms, including the severe hurricane season of 2005.

Past Research

Three major studies have provided extensive knowledge of GOM deepwater communities and habitats. The Pequegnat final report to MMS, *The Ecological Communities of the Continental Slope and Adjacent Regimes of the Northern Gulf of Mexico* (Pequegnat, 1983), primarily qualitative in nature, first described numerous hypotheses of depth zonation patterns and aspects of faunal differences between the Eastern and Western GOM. The first major quantitative deepwater benthos study in the GOM was that of LGL Ecological Research Associates Inc. (Gallaway et al., 1988) as part of the MMS *Northern Gulf of Mexico Continental Slope Study.* Gallaway et al. (1988) reported that, after their study, it was possible to predict with a reasonable degree of certainty the basic composition of the faunal communities on the northern GOM slope between 300 and 2,500 m (984 and 8,202 ft) water depths and between 85° and 94° W. longitude. This is approximately 75 percent of the northern GOM slope area. There was a reasonable degree of agreement between the faunal distribution results of the LGL study (Gallaway et al., 1988) and Pequegnat (1983). Because the deep GOM has only recently been investigated in any systematic way, a large number of species obtained during the LGL/MMS study were new to science. Texas A&M University, with numerous subcontractors, has recently completed the most detailed and comprehensive investigation of the deep GOM, titled *Northern Gulf of Mexico Continental Slope Habitat and Benthic Ecology*. These results are in final preparation at the time of this writing and are cited as Rowe and Kennicutt (in prepartion).

Microbiota

Less is known about the microbiota, primarily bacteria, in the GOM than the other size groups, especially in deep water. Very little is known about the microbiota group archaea. Environmental factors that control bacterial abundance in marine sediments remain poorly understood (Schmidt et al., 1998). While direct counts of bacteria have been coupled with some *in situ* and repressurized metabolic studies performed in other deep ocean sediments (Deming and Baross, 1993), none have been made in the deep GOM. Cruz-Kaegi (1998) made direct counts using a fluorescing nuclear stain at several depths down the slope, allowing bacterial biomass to be estimated from their densities and sizes. Mean biomass was estimated to be 2.37 g of C/m^2 for the shelf and slope combined, and 0.37 g of C/m^2 for the abyssal plain. In terms of biomass, data indicate that bacteria are the most important component of the functional infaunal biota. Cruz-Kaegi (1998) developed a carbon cycling budget based on estimates of biomass and metabolic rates in the literature. She discovered that, on the deep slope of the Gulf, the energy from organic carbon in the benthos is cycled through bacteria. Counts of bacteria in marine sediments center around 10^9 bacteria per ml fluid volume, in other words literally trillions per m^2 (Schmidt et al., 1998).

In Rowe and Kennicutt (in prepartion), bacteria abundance was measured at four depth horizons (0-1, 4-5, 9-10, and 14-15 cm) in triplicate cores at each of 59 stations ranging in depth from 19 to 3,732 m (62 to 12,244 ft). Results proved to be mixed, showing no significant difference in bacterial abundance between slope and abyssal sites, but there was a significant difference in terms of biomass over the full range of depth. Substantial additional bacterial biomass and abundance data is presented in Rowe and Kennicutt (in prepartion).

Meiofauna

The density of meiofauna (size: <0.063 mm) was reported as approximately two orders of magnitude greater than the density of macrofauna (0.063-0.3 mm) throughout the depth range of the GOM continental slope by LGL/MMS (Gallaway et al., 1988). Overall mean abundance was 707 individuals per 10 cm^2 (707,000 per m^2) ranging from a low of 200 to a high of 1,100. These values are among the highest reported for the deep sea (Thiel, 1983). Densities were generally similar to those previously reported and generally decreased with increasing depth by a factor of three between 300 and 3,000 m (984 and 9,842 ft). A total of 43 major groups were identified. Of these, representatives of five taxa of permanent meiofauna (Nematoda, Harpacticoidea, Polychaeta, Ostracoda, and Kinorhyncha), along with naupliar larvae (temporary meiofauna), comprised 98 percent of the collections as reported by Gallaway et al. (1988). The range of density values obtained for meiofauna varied by one order of magnitude. Some specific comparisons with depth showed a decisive decrease of abundance with depth (at the 5% statistical level), but this trend was not consistent through all seasons and areas of the GOM.

Rowe and Kennicutt (in prepartion) reported meiofauna results from a total of 586 samples from 51 stations in the study, yielding 1.71 x 10^5 individuals from 21 meiofauna taxa. Overall mean abundance was 263,000 per m^{-2}, less than half of that reported by Gallaway et al. (1988). Exceptionally high abundance was found at stations in the northeast region at depths ranging from approximately 450 to

1,900 m (1,476 and 6,234 ft) with a maximum number of 946,000 per m^2. Meiofauna biomass was dominated by the two dominant taxa, Nematoda and Harpacticoida. This final report (Rowe and Kennicutt, in prepartion) includes extensive analysis of diversity and biomass and a detailed section on harpacticoid copepod community structure.

Macrofauna

Gallaway et al. (1988) reported a total of 1,569 different taxa of macrofauna on the continental slope, 90 percent of those identified to the level of genus or species. Nearly all macrofaunal species were infaunal invertebrates considered nominally epifaunal or surface dwelling, although some taxa were normally found in surficial sediments. The major group was annelid taxa including 626 polychaete taxa. Overall abundance of macrofauna ranged from 518 to 5,369 individuals per m^2. Overall, there was also an approximate three-fold decrease in macrofaunal density with depth between 300 and 2,900 m, similar to meiofauna (Pequegnat et al., 1990). Macrofauna abundance was somewhat lower on the eastern transect compared to the central slope transects.

Rowe and Kennicutt (in prepartion) also made extensive box core collections over the entire range of the continental slope and obtained higher numbers than Gallaway et al. (1988). Regressions of animal abundance as a function of depth for the entire dataset indicate that mean density declines from about 10,000 down to about 3,000 per m^2 at the base of the escarpment, with further declines out to less than 1,000 out on the abyssal plain. Maximum values were found near Mississippi Canyon. Three macrofauna groups were analyzed in detail because of their numerical importance: the polychaetes, bivalve molluscs, and isopod crustacea. When considered as a whole, the macrofauna displayed more or less the same patterns exhibited by the individual groups, as might be expected. The Central Gulf area, in close proximity to the Mississippi River, had highest densities, whereas the far western transect had the lowest densities, at any given depth. The central axis of DeSoto Canyon also had high densities. The highest densities were located at the Mississippi Canyon head and these also had the lowest diversity values. Both Gallaway et al. (1988) and Rowe and Kennicutt (in prepartion) are referenced for extensive additional detail on macrofauna diversity and distribution.

Megafauna

Megafauna collections were made using two techniques in Gallaway et al. (1988): benthic photography and the use of an otter trawl ranging in depths between 300 and 2,882 m. Based on fish and invertebrates collected by trawling, invertebrates were 4-5 times more abundant than benthic fishes throughout all transects and designated depth zones. Other trends included higher densities of all megafauna in the study's Eastern GOM transect area (between 85°40′ and 85°15′ W. longitude) and lowest in the Central area (between 89°40′ and 89°20′ W. longitude) and a tendency of densities to decrease below a depth of 1,550 m. Overall, benthic fish densities ranged from 0 to 704 fish per hectare (10,000 m^2). Overall megafauna invertebrates ranged from 0 to 4,368 individuals per hectare. Results of the MMS/LGL studies (Gallaway et al., 1988) supported the zonation scheme proposed by Pequegnat (1983).

All 60 stations in the MMS/LGL continental slope study (Gallaway et al., 1988) were also sampled by quantitative photographic methods. Although up to 800 images were obtained at each of the stations, because of the relatively small area "sampled" by each photograph (approximately 2 m^2), abundance of most megafauna taxa was low. Megafauna that did appear in benthic photographs generally indicated much higher densities than that obtained by trawling, with variations being more than four orders of magnitude in some cases. Overall density from photography was 8,449 animals per hectare. The highest density of any organism sampled by photography was that of a small sea cucumber (never obtained by trawling) resulting in a peak density of 154,669/ha.

Megafauna invertebrates captured during trawling were between four and five times more abundant than fishes at all depths on all transects in terms of average density (Pequegnat et al., 1990). The density of megafauna obtained by trawling was 3,241/ha on the central transect, 6,267/ha on the western transect, and 9,463/ha on the eastern transect.

The more recent Gulfwide study reported by Rowe and Kennicutt (in prepartion) also included extensive megafauna sampling by both trawling techniques and benthic photography. A total of at least

185 species of megafaunal invertebrates (over 10 mm in greatest dimension, or attached to objects over 10 mm in size) were collected by trawl or trap during the study in 2000-2002. The amphipod *Eurythenes gryllus* was taken only in traps. Species richness was greatest in DeSoto Canyon at one station with 38 species. Four other stations resulted in more than 30 species, all in the eastern half of the basin. Stations on the Sigsbee Abyssal Plain had 20 or fewer species, as did stations of the Mississippi Trough.

Biomass was highest at stations of the DeSoto Canyon and a station in Mississippi Canyon, MT3. Much of the biomass was because of wet weight of holothuroids. Many species of echinoderms, sea anemones, and crustaceans were widespread in geographic distribution. The most common group of invertebrates was the Crustacea, with 58 species. Three of these were collected and identified for the first time in the GOM.

Megafaunal densities from photographs taken during the Rowe and Kennicutt (in prepartion) and LGL/MMS (Gallaway et al., 1988) studies were compared with one another by site, transect, region, and program in Rowe and Kennicutt (in prepartion). The ANOVA results indicate that megafaunal density numbers achieved during the latter work are not statistically different from those of the prior LGL/MMS work for any of these cases. Furthermore, the studies share four out of the top six taxa by density, and while LGL/MMS results list four more taxa groups than the latter work, these are all groups that are relatively rare with less than eight individuals/ha appearing study wide. Therefore, it would seem that the megafaunal populations of the northern GOM continental slope have not changed significantly in the past 15 years in terms of numbers and types of animals.

While the previous groups of sediment-dwelling organisms are considered immobile and unable to avoid disturbances caused by OCS activities, megafauna could be categorized into two groups: a nonmotile or very slow-moving group including many invertebrates; and a motile group including fish, crustaceans, and some types of invertebrates, such as semipelagic sea cucumbers, that can readily move over substantial distances.

3.2.3. Marine Mammals

Twenty-nine species of marine mammals occur in the GOM (Davis et al., 2000). The GOM's marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales), as well as the order Sirenia, which includes the manatee and dugong. Within the GOM, there are 28 species of cetaceans (7 mysticete and 21 odontocete species) and 1 sirenian species, the manatee (Jefferson et al., 1992) (**Table 3-4**).

3.2.3.1. Threatened or Endangered Species

Five baleen whales (the northern right, blue, fin, sei, and humpback), one toothed whale (the sperm whale), and one sirenian (the West Indian manatee) occur in the GOM and are listed as endangered under the Endangered Species Act (ESA). The sperm whale is common in oceanic waters of the northern GOM and appears to be a resident species, while the baleen whales are considered rare or extralimital in the Gulf (Würsig et al., 2000). The West Indian manatee (*Trichechus manatus*) typically inhabits only coastal marine, brackish, and freshwater areas.

3.2.3.1.1. Cetaceans—Mysticetes

The species of endangered and threatened mysticetes reported in the GOM region are the northern right whale, blue whale, fin whale, sei whale, and humpback whale.

The northern right whale (*Eubalaena glacialis*) inhabits primarily temperate and subpolar waters. Right whales forage primarily on subsurface concentrations of zooplankton (Watkins and Schevill, 1976; Leatherwood and Reeves, 1983; Jefferson et al., 1993). Northern right whales range from wintering and calving grounds in coastal waters of the southeastern U.S. to summer feeding, nursery, and mating grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Five major congregation areas have been identified for the western North Atlantic right whale (southeastern U.S. coastal waters, Great South Channel, Cape Cod Bay, Bay of Fundy, and Scotian Shelf). This species is extralimital in the GOM (Würsig et al., 2000), and confirmed records in the GOM consist of a single stranding in Texas in 1972 (Schmidly et al., 1972), a sighting off Sarasota County, Florida, in 1963

(Moore and Clark, 1963; Schmidly, 1981), and sightings of a female and calf in April 2004 and January 2006. There are no abundance estimates for the northern right whale in the GOM.

The blue whale (*Balaenoptera musculus*) is the largest of all marine mammals. The blue whale occurs in all major oceans of the world; some blue whales are resident, some are migratory (Jefferson et al., 1993; USDOC, NMFS, 1998a). Those that migrate move to feeding grounds in polar waters during spring and summer after wintering in subtropical and tropical waters (Yochem and Leatherwood, 1985). They feed almost exclusively on concentrations of zooplankton (Yochem and Leatherwood, 1985; Jefferson et al., 1993). They are considered extralimital in the GOM (Würsig et al., 2000), with the only records consisting of two strandings on the Texas coast (Lowery, 1974). There are no abundance estimates for the blue whale in the GOM.

The fin whale (*Balaenoptera physalus*) is an oceanic species that occurs worldwide and is most commonly sighted where deep water approaches the coast (Jefferson et al., 1993). Fin whales feed on concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The fin whale makes seasonal migrations between temperate waters, where it mates and calves, and polar feeding grounds that are occupied during summer months. Fin whale presence in the northern GOM is considered rare (Würsig et al., 2000). There are only seven reliable reports of fin whales in the northern GOM, indicating that fin whales are not abundant in the GOM (Jefferson and Schiro, 1997).

The sei whale (*Balaenoptera borealis*) is an oceanic species that occurs in tropic to polar regions and is more common in the mid-latitude temperate zones. It is not often seen close to shore (Jefferson et al., 1993). Sei whales feed on concentrations of zooplankton, small fishes, and cephalopods (Gambell, 1985a; Jefferson et al., 1993). They are considered rare in the GOM (Würsig et al., 2000), based on records of one stranding in the Florida Panhandle and three in eastern Louisiana (Jefferson and Schiro, 1997). There are no abundance estimates for the sei whale in the GOM.

The humpback whale (*Megaptera novaeangliae*) occurs in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical banks, where they breed and calve (Jefferson et al., 1993). Humpback whales feed on concentrations of zooplankton and fishes using a variety of techniques that concentrate prey for easier feeding (Winn and Reichley, 1985; Jefferson et al., 1993). Humpback whales are considered rare in the GOM (Würsig et al., 2000) based on a few confirmed sightings and one stranding event. There are no abundance estimates for the humpback whale in the GOM.

3.2.3.1.2. Cetaceans—Odontocetes

The sperm whale (*Physeter macrocephalus*) is found worldwide in deep waters between approximately 60° N. and 60° S. latitude (Whitehead, 2002), although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al., 1993). As deep divers, sperm whales generally inhabit oceanic waters, but they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al., 1993). Sperm whales prey on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson et al., 1993).

The sperm whale is the only great whale that is considered common in the northern GOM (Fritts et al., 1983a; Mullin et al., 1991; Davis and Fargion, 1996; Jefferson and Schiro, 1997). Aggregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River Delta in waters that are 500-2,000 m (1,641-6,562 ft) in depth (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). They are often concentrated along the continental slope in or near cyclones and zones of confluence between cyclones and anticyclones (Davis et al., 2000). Consistent sightings and satellite tracking results indicate that sperm whales occupy the northern GOM throughout all seasons (Mullin et al., 1994a; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000. Jochens et al, 2006). For management purposes, sperm whales in the GOM are provisionally considered a separate stock from those in the Atlantic and Caribbean (Waring et al., 1997). Estimated abundance for sperm whales in the northern GOM is 1,349 individuals (Waring et al., 2004).

Life History

Females and juveniles form pods that are restricted mainly to tropical and temperate latitudes (between 50°N. and 50°S. latitude), while the solitary adult males can be found at higher latitudes (between 75°N. and 75°S. latitude) (Reeves and Whitehead, 1997). In the western North Atlantic they range from Greenland to the GOM and the Caribbean.

Evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce vocalizations (Norris and Harvey, 1972; Cranford, 1992). This suggests that vocalizations are extremely important to sperm whales. The function of vocalizations is relatively well-studied (Weilgart and Whitehead, 1997; Goold and Jones, 1995). Long series of monotonous, regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Sperm whales also use unique stereotyped click sequence "codas" (Mullins et al., 1988; Watkins 1977; Adler-Fenchel, 1980; Watkins et al., 1985), according to Weilgart and Whitehead (1988), to possibly convey information about the age, sex, and reproductive status of the sender. Groups of closely related females and their offspring have group-specific dialects (Weilgart and Whitehead, 1997).

Sperm whales generally occur in water depths greater than 180 m. While they may be encountered almost anywhere on the high seas, their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves, 1983). Waring et al. (1993) suggest sperm whale distribution in the Atlantic is closely correlated with the Gulf Stream edge. Bull sperm whales migrate much farther poleward than the cows, calves, and young males. Because most of the breeding herds are confined almost exclusively to warmer waters, many of the larger mature males return in the winter to the lower latitudes to breed. It is not known whether Gulf sperm whales exhibit similar seasonal movement patterns; research to date does not support such seasonal movement patterns. Sperm whale presence in the Gulf is year-round; however, because of the lack of adult males observed in the GOM, it is not known whether females leave the area to mate or whether males sporadically enter the area to mate with females. However, recent tag data indicates that this group offshore of the Mississippi River Delta remains in the northern Gulf area year-round and represents a resident population (Jochens et al., 2005). Davis et al. (2000 and 2002) reported that low-salinity, nutrient-rich water may occur over the continental slope near the mouth of the Mississippi River or be entrained within the confluence of a cyclone-anticyclone eddy pair and transported over the narrow continental shelf south of the Mississippi River Delta. This creates an area of high primary and secondary productivity in deep water that may explain the presence of the resident population of endangered sperm whales within 100 km (62 mi) of the Mississippi River Delta (Townsend, 1935; Davis and Fargion, 1996; Davis et al., 2000; Weller et al., 2000).

Deep water is their typical habitat, but sperm whales also occur in coastal waters at times (Scott and Sadove, 1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke, 1956), and with the movement of cyclonic eddies in the northern Gulf (Davis et al., 2000 and 2002). Although sperm whales have been sighted throughout the GOM, sperm whales south of the Mississippi River Delta apparently concentrate their movements to stay in or near variable areas of upwelling, or cold-core rings (Würsig et al., 2000; Davis et al., 2002). Presumably this is because of the greater productivity inherent in such areas, which would provide concentrated sources of forage species for these whales. The continental margin in the north-central Gulf is only 20 km (12 mi) wide at its narrowest point, and the ocean floor descends quickly along the continental slope, reaching a depth of 1,000 m (3,281 ft) within 40 km (25 mi) of the coast. This unique area of the GOM brings deepwater organisms within the influence of coastal fisheries, contaminants, and other human impacts on the entire northern Gulf. Low salinity, nutrient-rich water from the Mississippi River contributes to enhanced primary and secondary productivity in the north-central Gulf and may explain the presence of sperm whales in the area (Davis et al., 2000).

Sperm whales are noted for their ability to make prolonged, deep dives, and are likely the deepest and longest diving mammal. Typical foraging dives last 40 minutes and descend to about 400 m (1,312 ft), followed by approximately 8 minutes of resting at the surface (Gordon, 1987; Papastavrou et al., 1989). However, dives of over 2 hours and deeper than 3.3 km (2.1 mi) have been recorded (Clarke, 1976; Watkins et al., 1985; Watkins et al., 1993) and individuals may spend extended periods of time at the surface to recover. Descent rates recorded from echo-sounders were approximately 1.7 m/sec and nearly vertical (Goold and Jones, 1995). There are no data on diurnal differences in dive depths in sperm whales. Dive depth may be dependent upon temporal variations in prey abundance.

Cephalopods (i.e., squid, octopi, cuttlefishes, and nautilus) are the main dietary component of sperm whales. The ommastrephids, onychoteuthids, cranchids, and enoploteuthids are the cephalopod families that are numerically important in the diet of sperm whales in the GOM (Davis et al., 2002). Other populations are known to also take significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes, especially mature males in higher latitudes (Clarke, 1962 and 1979). Postulated feeding and hunting methods include lying suspended and relatively motionless near the ocean floor and ambushing prey, attracting squid and other prey with bioluminescent mouths, or stunning prey with ultrasonic sounds (Norris and Mohl, 1983; Würsig et al., 2000). Sperm whales occasionally drown after becoming entangled in deep-sea cables that wrap around their lower jaw, and non-food objects have been found in their stomachs, suggesting these animals may at times cruise the ocean floor with open mouths (Würsig et al., 2000; Rice, 1989).

Population Dynamics

There is evidence based on year-round occurrence of strandings, opportunistic sightings, whaling catches, and recent sperm whale survey data that sperm whales in the GOM may be found throughout deep waters of the GOM (Schmidley, 1981; Hansen et al., 1996; Davis et al., 2002; Mullin and Fulling, 2004). The NMFS treats sperm whales in the GOM as a distinct stock in the Marine Mammal Stock Assessment Report (Waring et al., 2004) and recent research supports this. Seasonal aerial surveys have confirmed that sperm whales are present in the northern GOM in all seasons. Sightings are more common during summer (Mullin et al., 1991; Mullin et al., 1994c; Mullin and Hoggard, 2000; Mullin and Fulling, 2004) but may be an artifact of movement patterns of sperm whales associated with reproductive behavior, hydrographic features, or other environmental and seasonal factors.

Female sperm whales attain sexual maturity at the mean age of 8 or 9 years and a length of about 9 m (30 ft) (Kasuya, 1991; Würsig et al., 2000). The mature females ovulate April through August in the Northern Hemisphere. During this season one or more large mature bulls temporarily join each breeding school. A single calf is born at a length of about 4 m, after a 15- to 16-month gestation period. Sperm whales exhibit alloparental (assistance by individuals other than the parents in the care of offspring) guarding of young at the surface (Whitehead, 1996) and alloparental nursing (Reeves and Whitehead, 1997). Calves are nursed for 2-3 years (in some cases, up to 13 years); and the calving interval is estimated to be about 4-7 years (Kasuya, 1991; Würsig et al., 2000).

Males have a prolonged puberty and attain sexual maturity at between 12 and 20 years, and a body length of 12 m; however, they may require another 10 years to become large enough to successfully compete for breeding rights (Kasuya, 1991; Würsig et al., 2000). Bachelor schools consist of maturing males who leave the breeding school and aggregate in loose groups of about 40 animals. As the males grow older, they separate from the bachelor schools and remain solitary most of the year (Best, 1979).

Density estimates of 2.36 whales per 1,000 km^2 were calculated for the northern GOM by Whitehead (2002). The age distribution of the sperm whale population is unknown, but they are believed to live at least 60 years. Potential sources of natural mortality in sperm whales include killer whales and the papilloma virus (Lambertsen et al., 1987). Little is known of recruitment and mortality rates; however, recent abundance estimates based on surveys indicate that the population appears to be stable, but NMFS believes there are insufficient data to determine population trends in the GOM for this species at this time (Waring et al., 2004).

Status and Distribution

Sperm whales are found throughout the world's oceans in deep waters between about 60°N. and 60°S. latitude (Leatherwood and Reeves, 1983; Rice, 1989). The primary factor for the population decline that precipitated ESA listing was commercial whaling in the 18th, 19th, and 20th centuries for ambergris and spermaceti. The International Whaling Commission (IWC) estimates that nearly 250,000 sperm whales were killed worldwide in whaling activities between 1800 and 1900. A commercial fishery for sperm whales operated in the GOM during the late 1700’s to the early 1900’s, but the exact number of whales taken is not known (Townsend, 1935). The overharvest of sperm whales resulted in their alarming decline in the last century. From 1910 to 1982, there were nearly 700,000 sperm whales killed worldwide from whaling activities (IWC Statistics, 1959-1983) (USDOC, NMFS, 2002a). Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead, 1997). Since the ban on nearly all hunting of sperm whales, there has been little evidence that direct effects of anthropogenic causes of mortality or injury are significantly affecting the recovery of sperm whale stocks (Perry et al., 1999), yet the effects of these activities on the behavior of sperm whales has just recently begun to be studied. Sperm whales are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. At present, the global population of sperm whales is estimated to be at 32 percent of its pre-whaling number (Whitehead, 2002).

Since sperm whales were listed under the ESA, a concern for the effects of anthropogenic activities on the physiology and behavior of marine mammals has received much attention. Sperm whales have been identified as species of concern in the GOM in relation to shipping, seismic surveys, and mineral production (Jasny, 1999), although the studies of the effects of seismic pulses on sperm whales have been relatively few and have been largely inconclusive. The debate on the biological significance of certain reactions, or no reaction at all, makes any results difficult and sometimes contentious to interpret. However, many reported reactions to anthropogenic noise deserve special attention in assessing impacts to sperm whales and marine life in general. Sperm whale vocalization and audition are important for echolocation and feeding, social behavior and intragroup interactions, and maintaining social cohesion within the group. Anthropogenic sources from vessel noise, noise associated with oil production, seismic surveys, and other sources have the potential to impact sperm whales (e.g., behavioral alteration, communication, feeding ability, disruption of breeding and nursing, and avoidance of locales where audible sounds are being emitted).

Andrew et al. (2002) reported that, over a 33-year period, increases in shipping sound levels in the ocean may account for a 10-dB increase in ambient noise between 20 and 80 Hz and between 200 and 300 Hz, and a 3-dB increase in noise at 100 Hz on the continental slope off Point Sur, California. Although comparable data are not available for the GOM, it is likely that similar ambient noise increases have occurred. Much of the change is expected to be attributable to commercial shipping (greater numbers of ships in the Gulf and larger ship size are both factors). However, the expansion of oil and gas industry activities, including more structures, more exploration (seismic surveys) and drilling, a larger service boat fleet, and much greater distances to travel to deep water installations, has also contributed to more sound in Gulf waters.

Documented takes of sperm whales primarily involve offshore fisheries such as the offshore lobster pot fishery and pelagic driftnet and longline fisheries. Sperm whales have learned to depredate sablefish from longline gear in the Gulf of Alaska and toothfish from longline operations in the south Atlantic Ocean. No direct injury or mortality has been recorded during hauling operations, but lines have had to be cut when whales were caught on them (Ashford et al., 1996). Because of their generally more offshore distribution and their benthic feeding habits, sperm whales are less subject to entanglement than are right or humpback whales. Sperm whales have been taken in the pelagic drift gillnet fishery for swordfish and could likewise be taken in the shark drift gillnet fishery on occasions when they may occur more nearshore, although this likely does not occur often. Although no interaction between sperm whales and the longline fishery have been recorded in the U.S. Atlantic, as noted above, such interactions have been documented elsewhere. The Southeast U.S. Marine Mammal Stranding Network received reports of 16 sperm whales that stranded along the GOM coastline from 1987 to 2001 in areas ranging from Pinellas County, Florida, to Matagorda County, Texas. One of these whales had deep, parallel cuts posterior to the dorsal ridge that were believed to be caused by the propeller of a large vessel; this trauma was assumed to be the proximate cause of the stranding.

Recent Research

Since the last multisale consultation and Biological Opinion from NMFS, MMS conducted annual research cruises under the Sperm Whale Seismic Study (SWSS) program through 2005. The final year, 2006, is being devoted to data analysis and the publication of a synthesis report, including the various facets of SWSS. A detailed report of the research conducted from 2002 through 2004 has been published (Jochens et al., 2005) and is summarized below. This report and others from the SWSS program are available online at http://seawater.tamu.edu/SWSS/.

Three objectives were identified for the SWSS program:

(1) establish the normal behavior of sperm whales in the northern GOM;

(2) characterize habitat use; and

(3) determine possible changes in the behavior of sperm whales when subjected to manmade noise, particularly from seismic airgun arrays.

Behavior

The intent of Objective 1 was to describe baseline sperm whale behavior. However, the long history in the GOM of human activity and human-generated sound, including in areas that sperm whales inhabit, makes the determination of baseline behavior of unexposed animals impossible. There may be some level of habituation of the GOM sperm whale population to such activities and the associated sounds.

Genetic analyses, coda vocalizations, and population structure support NOAA Fisheries Service's provisional consideration of the northern GOM sperm whale stock as distinct from the U.S. Atlantic stock. Preliminary SWSS findings also indicate that GOM sperm whales are different from other populations. Significant genetic differences have been identified between northern GOM sperm whale population and the populations of sperm whales from the Mediterranean Sea, the North Sea, and the North Atlantic Ocean. The preliminary analyses of coda vocalizations of GOM sperm whales finds significant differences in these as compared with sperm whale populations in the rest of the Atlantic. The mixed group coda vocalizations in the GOM belong to an acoustic clan that is rare in other areas, and this leads researchers to believe that sperm whale groups from other clans rarely enter the northern GOM.

Population structure of sperm whale groups studied in the northern GOM between Mississippi Canyon and DeSoto Canyon showed variations from other populations studied in similar detail. The mean group size of the GOM sperm whales was 9-11 individuals, which is about half of the group size elsewhere. Whaling data from the GOM indicates that northern GOM sperm whales are smaller in length (1.5-2 m (5-7 ft) smaller) now than when those data were collected. The GOM sperm whales are also smaller than the whales in the Gulf of California, which have been studied using similar measurement techniques. The behavior and seasonality of large, mature males in the GOM is still a mystery as very few have been recorded and none were seen in 2004. The typical female/immature male mixed groups observed in the GOM have high site fidelity, which is not described elsewhere for females/immatures but is comparable to the site fidelity of bachelor males off New Zealand. No matches were found between the 185 individuals identified in the GOM and the 2,500+ individuals identified in the rest of the Atlantic (in the North Atlantic and Mediterranean Sperm Whale Catalog). These results suggest segregation between GOM sperm whales and those in the rest of the Atlantic that, based on the lack of matches and the differences in coda vocalizations, has likely spanned decades. All of these data support the management treatment of northern GOM sperm whales as a separate population.

The social organization of northern GOM sperm whales was examined by combining visual and acoustic observations and genetic analyses. A strong segregation in distribution between female/immatures groups and bachelor groups/lone males was found in at least one year of study. Female/immature groups were found south of the Mississippi River Delta and Mississippi Canyon and in the Western GOM, and these groups displayed high site fidelity for these areas. Bachelor groups and lone males were mainly found in DeSoto Canyon and along the Florida slope. Researchers point out that, although site fidelity is supported in most of the recent research, most of the research has focused on the Mississippi Canyon/DeSoto Canyon areas, and other portions of the GOM are not well represented in the study. The most recent calculation of first-year calves to group size was 11.5 percent, which is similar in magnitude to that in several areas of the South Pacific. Observations from the sailboat in 2004, which was a new addition to the SWSS project, found first-year calves in most groups of female/immature sperm whales that were visually tracked for at least 12 hours.

Sperm whale movement in the northern GOM was characterized using S-Tag data, visual and acoustic observation and tracking, and D-Tag data. Thirty-nine whales were tracked with S-Tags and 2,826 locations were received between August 2001 and October 2004. Travel speeds ranged from 0.2 to 2.3 km/hr (1.4 mph) and averaged 0.7 km/hr (0.4 mph), with an average yearly distance traveled of 3,719 km (2,311 mi). S-Tagged females were not found over deeper water nearly as often as males, but rather tended to occupy the upper slope edge. Several males, conversely, moved offshore and traveled to the southern portions of the GOM. Tag data confirmed the importance of the Mississippi River Delta area as a year-round home range for whales tagged in that region. Data also indicated that males have a larger individual range than females, with emphasis over deeper waters.

In 2004, groups of sperm whales in the area south of the Mississippi River Delta were followed by a sailboat equipped for both visual and acoustic observation. Observation periods ranged between 12 and 50 hours. This study recorded an average horizontal daily displacement of 35 km (22 mi). Compared with sperm whales in other oceans, the GOM whales moved over a smaller area and stayed within a particular area for a longer period. Researchers noted that such a small horizontal displacement, along with the recorded small-scale movement patterns, suggested a high feeding success rate. This could indicate that the whales are feeding on small but dense patches of prey.

D-tagged sperm whales in the GOM dove to an average depth of 659 m (2,162 ft) (range of 326.8-972.0 m (1,072.2-3,189.0 ft)) as compared with an average depth of 966 m (3,169 ft) (range of 830.3-1,202.2 m (2,724.1-3,944.2ft)) for D-tagged sperm whales in the North Atlantic. In other dive-related behaviors, including bottom duration, number of "buzzes" per dive, and foraging phase duration, the GOM sperm whales and the North Atlantic sperm whales were similar. The foraging phase averaged 29 minutes and accounted for 60 percent of the dive duration. Whales spent an average of 11 minutes on the surface following a deep dive.

Habitat Use

The 2002-2004 SWSS cruises searched for whales mainly in the area between Mississippi Canyon and DeSoto Canyon. Surveys were generally run along the 1,000-m (3,281-ft) isobath, with water depths typically 800-1,200 m (2,625-3,937 ft). Researchers conducted *in-situ* measurements from the research vessel of several environmental parameters including, temperature, salinity, currents, and near-surface chlorophyll. Measurements were also gathered on sea-surface height and ocean color through remote sensing. These data were merged with the presence or absence of sperm whales within 5-10 km (3-6 mi) of the ship to address Objective 2. During the months when no cruises were in the field, remotely sensed data were matched with location data from S-tagged whales.

Researchers hypothesized that locally high chlorophyll features that persist for periods of months, particularly cyclonic eddies or eddy-induced off-margin flows, provide the sustained primary production needed for higher biological production that can be feeding grounds for sperm whales along the continental slope. Multiyear measurements demonstrated a very dynamic environment with striking year-to-year differences in the locations along the 1,000-m (3,281-ft) isobath where similar oceanographic features occurred. In the summers of 2002-2003, most sperm whale sightings occurred in regions of negative sea-surface height and/or higher-than-average surface chlorophyll. This was consistent with the feeding grounds hypothesis. However, 2004 proved to be a very different story. Few of the whale encounters were in areas of negative sea-surface height and/or higher-than-average surface chlorophyll. This finding was not only anomalous to the 2002-2003 SWSS results but also to those of the SWAMP cruises in 2000-2001 and the GulfCet II work in the late 1990's. Further analysis is anticipated.

The dynamic nature of the oceanography of the northern GOM slope occurred within the course of one season, as well as over annual periods. The Mississippi Canyon region has been an area of consistent sperm whale sightings over several years and research programs. A Loop Current eddy was located seaward but close to Mississippi Canyon in early summer 2003. The resultant water flow brought low-chlorophyll, low-nutrient Caribbean water into Mississippi Canyon from the Loop Current eddy. Researchers using both visual and acoustic surveys found sperm whales to be very uncharacteristically rare in the Mississippi Canyon region during this event. One month later, sperm whales were observed in the Canyon area, and remote-sensing fields showed that the eddy had moved farther seaward and away from the Canyon area. The more typical water flow had been reestablished.

Analyses of the spatial and temporal locations over time of 39 S-tagged whales produced some interesting results. Most of the tagged whales had been biopsied (30 of 39) and thus gender was known (24 females, 6 males). Significant differences were observed in the median bottom depth at locations for satellite-tracked males (1,171 m) and females (884 m). Although the depths overlapped, female sperm whales were located more frequently on the upper continental slope. Males were also found in this location but some males moved into the central GOM and over the lower continental slope and the abyssal plain. Significant differences in habitat were also noted between meandering and transit behaviors. The median depth for meandering was 895 m (2,936 ft) and for transit was 968 m (3,176 ft). These two behaviors also had differing sea-surface height values (-3.9 cm (-1.5 in) for meandering and -7.1 cm (2.8 ft) for transit). The fact that both of these height values are negative supports the hypothesis of a preference for regions of cyclonic circulation. Researchers suggest that the significant difference in mean sea height between meandering and transit movement types may indicate differential use of various areas of the GOM by sperm whales. A trend was noted for tracked whales to aggregate near the Mississippi Canyon and Mississippi River Delta areas in the summer. Some of the whales stayed in this region for several months and others dispersed in different directions the rest of the year. It should be noted that most of the whales were tagged in the Mississippi Canyon and Mississippi River Delta regions; thus, the site fidelity patterns shown by these whales may or may not be similar to whales from other areas in the GOM. The SWSS 2005 cruise tagged whales from areas farther west and perhaps those data will help address this issue.

Sperm Whales and Manmade Noise

Experiments for SWSS Objective 3 were designed to investigate the sound exposure level at which behavioral changes begin to occur. The primary tool for this investigation was the D-tag used in conjunction with seismic airgun controlled exposure experiments (CEE's) to quantify changes in the behavior of sperm whales throughout their dive cycle. Eight whales were tagged over two field seasons (2002-2003). The acoustic exposure and foraging behavior of these whales were recorded on the D-tag before, during, and after a 1- to 2-hr controlled sound exposure to typical airgun arrays. The maximum sound level exposures for the eight whales were between 130 and at least 162 dBp-p re 1 μPa (measurement of sound level in water) at ranges of 1.5-12.8 km (0.9-8.0 mi) from the sound source.

The whales showed no change to diving behavior or direction of movement during the gradual ramp-up or during the full-power sound exposures. There was no avoidance behavior toward the sound source. Foraging behavior was temporarily altered for the whale that was approached most closely. The surface resting period was prolonged hours longer than typical, but normal foraging behavior resumed immediately after the airguns ceased. The increased surface period may be a type of vertical avoidance to the sound source as the received sound level at the surface is expected to be less than farther down in the water column. There was a decrease of "buzzes" (distinctive echolocation sounds thought to be produced by sperm whales during prey capture attempts) in the foraging dives of the other exposed whales when compared with those of unexposed whales; however, the decrease was not statistically significant. Other analyses applied to these results led the researchers to suggest that a 20 percent decrease in foraging attempts at exposure levels ranging from <130 to 162 dBp-p re 1 μPa at distances of roughly 1-12 km (1-7 mi) from the sound source is more likely than no effect.

Whale locations from S-tags were compared with positions of active seismic vessels to determine whether tagged whales occurred less frequently than expected in areas of active seismic surveys in the GOM (potential vessel avoidance behavior). Chi-square testing and Monte Carlo simulations revealed no evidence that the data (whale locations) were nonrandomly distributed. However, the researchers caution that this apparent lack of avoidance to the seismic vessels is based on a very small sample size and cannot be used to refute a possible behavioral response. The sperm whale sightings of the visual team aboard the *Gyre* were also analyzed to investigate medium-term responses of whales to seismic surveys occurring in the area. No significant responses were observed in (1) the heading relative to the bearing to seismic surveys, (2) time spent at the surface, or (3) surfacing rate in the comparisons of matched pairs 2 hours before and 2 hours after line starts and line ends for survey lines within 100, 50, or 25 mi.

The results of these three independent approaches suggest that sperm whales display no horizontal avoidance to seismic surveys in the GOM. However, these observations are based on very few exposures <160 dBp-p re 1 μPa. Also, these experiments were carried out in an area with substantial human activity, and the whales are not naive to human-generated sounds.

3.2.3.1.3. Sirenians

The West Indian manatee (*Trichechus manatus*) is the only sirenian occurring in tropical and subtropical coastal waters of the southeastern U.S., the GOM, and the Caribbean Sea (Jefferson et al., 1993; O'Shea et al., 1995). There are two subspecies of the West Indian manatee: the Florida manatee (*T. m. latirostris*), which ranges from the northern GOM to Virginia; and the Antillean manatee (*T. m. manatus*), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea.

Manatees are herbivores that feed opportunistically on a wide variety of submerged, floating, and emergent vegetation (USDOC, FWS, 2001i). Manatees primarily use open coastal (shallow nearshore) areas, and estuaries, and they are also found far up in freshwater tributaries. Shallow grassbeds with access to deep channels are their preferred feeding areas in coastal and riverine habitats (near the mouths of coastal rivers and sloughs are used for feeding, resting, mating, and calving (USDOC, FWS, 2001i).

During warmer months, manatees are common along the Gulf Coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida, and are less common farther westward. In winter, the GOM subpopulations move southward to warmer waters. The winter range is restricted to waters at the southern tip of Florida and to waters near localized warm-water sources, such as power plant outfalls and natural springs in west-central Florida. Crystal River in Citrus County is typically the northern limit of the manatee's winter range on the Gulf Coast. Manatees are uncommon west of the Suwannee River in Florida and are infrequently found as far west as Texas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro et al., 1998). The Florida Gulf Coast population of manatees is estimated to be approximately 1,520 individuals (USDOC, FWS, 2001i).

3.2.3.2. Nonendangered Species

3.2.3.2.1. Cetaceans—Mysticetes

The Bryde's whale (*Balaenoptera edeni*) is found in tropical and subtropical waters throughout the world. The Bryde's whale feeds on small pelagic fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993). Bryde's whales in the northern GOM, with few exceptions, have been sighted along a narrow corridor near the 100-m (328-ft) isobath (Davis and Fargion, 1996; Davis et al., 2000). Most sightings have been made in the DeSoto Canyon region and off western Florida, although there have been some in the west-central portion of the northeastern GOM. The best estimate of abundance for Bryde's whales in the northern GOM is 40 individuals (Waring et al., 2004).

The minke whale (*Balaenoptera acutorostrata*) is the second smallest baleen whale and is found in all the world's oceans. They feed on a variety of marine invertebrates (copepods and squid) and fishes (Jefferson et al., 1993). At least three geographically isolated populations are recognized: North Pacific, North Atlantic, and Southern Hemisphere. The North Atlantic population migrates southward during the winter months to the Florida Keys and the Caribbean Sea. Minke whales are considered rare in the GOM, with the only confirmed records coming from stranding information (Würsig et al., 2000). Most records from the GOM have come from the Florida Keys, although strandings in western and northern Florida, Louisiana, and Texas have been reported (Jefferson and Schiro, 1997). There are no abundance estimates for minke whales in the GOM.

3.2.3.2.2. Cetaceans — Odontocetes

Family Kogiidae

The pygmy sperm whale (*Kogia breviceps*) has a worldwide distribution in temperate to tropical waters (Caldwell and Caldwell, 1989). They feed mainly on squid but will also eat crab, shrimp, and smaller fishes (Würsig et al., 2000). In the GOM, they occur primarily along the continental shelf edge and in deeper waters off the continental shelf (Mullin et al., 1991).

The dwarf sperm whale (*Kogia sima*) can also be found worldwide in temperate to tropical waters (Caldwell and Caldwell, 1989). It is believed that they feed on squid, fishes, and crustaceans (Würsig et al., 2000). In the GOM, they are found primarily along the continental shelf edge and over deeper waters off the continental shelf (Mullin et al., 1991).

At sea, it is difficult to differentiate dwarf from pygmy sperm whales (*Kogia breviceps*), and sightings are often grouped together as "*Kogia* spp." The best estimate of abundance for dwarf and pygmy sperm whales combined in the northern GOM is 742 individuals (Waring et al., 2004).

Beaked Whales (Family Ziphiidae)

Beaked whales in the GOM are identified either as Cuvier's beaked whales or are grouped into an undifferentiated complex (*Mesoplodon* spp. and *Ziphius* spp.) because of the difficulty of at-sea identification. In the northern GOM, they are broadly distributed in waters greater than 1,000 m (3,281 ft) over lower slope and abyssal landscapes (Davis et al., 1998a and 2000). The abundance estimate for the Cuvier's beaked whale is 95 animals, and for the undifferentiated beaked whale complex in the northern GOM, it is 106 individuals (Waring et al., 2004).

The Sowerby's beaked whale (*Mesoplodon bidens*) occurs in cold temperate to subarctic waters of the North Atlantic and feeds on squid and small fishes (Würsig et al., 2000). It is represented in the GOM by only a single record, a stranding in Florida; this record is considered extralimital since this species normally occurs much farther north in the North Atlantic (Jefferson and Schiro, 1997). There are no abundance estimates for the GOM.

The Gervais' beaked whale (*Mesoplodon europaeus*) appears to be widely but sparsely distributed worldwide in temperate to tropical waters (Leatherwood and Reeves 1983). Little is known about their life history, but it is believed that they feed on squid (Würsig et al., 2000). Stranding records suggest that this is probably the most common mesoplodont in the northern GOM (Jefferson and Schiro, 1997).

The Blainville's beaked whale (*Mesoplodon densirostris*) is distributed throughout temperate and tropical waters worldwide, but it is not considered common (Würsig et al., 2000). Little life history is known about this secretive whale, but it is known to feed on squid and fish.

Cuvier's beaked whale (*Ziphius cavirorostris*) is widely (but sparsely) distributed throughout temperate and tropical waters worldwide (Würsig et al., 2000). Their diet consists of squid, fishes, crabs, and starfish. Sightings data indicate that Cuvier's beaked whale is probably the most common beaked whale in the GOM (Jefferson and Schiro, 1997; Davis et al., 1998a and 2000).

Dolphins (Family Delphinidae)

The Atlantic spotted dolphin (*Stenella frontalis*) is endemic to the Atlantic Ocean in tropical to temperate waters (Perrin et al., 1994a). They are known to feed on a wide variety of fishes, cephalopods, and benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Perrin et al., 1994a). In the GOM they are commonly found in continental shelf waters less than 200 m (656 ft) in depth, primarily from 10 m (33 ft) on the shelf to up to 500 m (1,640 ft) on the slope. The abundance estimate for Atlantic spotted dolphins is 30,947 individuals (Waring et al., 2004).

The bottlenose dolphin (*Tursiops truncates*) is a common inhabitant of the continental shelf and upper slope waters of the northern GOM. Bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, and shrimp (Davis and Fargion, 1996; Jefferson and Schiro, 1997; Wells and Scott, 1999). There appears to be two ecotypes of bottlenose dolphins, a coastal form and an offshore form (Hersh and Duffield, 1990; Mead and Potter, 1990). The coastal or inshore stock(s) is genetically isolated from the offshore stock (Curry and Smith, 1997). In the northern GOM, bottlenose dolphins appear to have an almost bimodal distribution: shallow water (16-67 m) and a shelf break (about 250 m) region. These regions may represent the individual depth preferences of the coastal and offshore forms (Baumgartner, 1995). The best estimate of abundance for the northern GOM oceanic stock and the continental shelf stock of bottlenose dolphins in the GOM is 27,559 individuals (Waring et al., 2004).

The Clymene dolphin (*Stenella clymene*) is endemic to tropical and subtropical waters of the Atlantic Ocean (Perrin and Mead, 1994). This species is thought to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994c). Data suggest that Clymene dolphins are widespread within deeper GOM waters (i.e., shelf edge and slope) (Davis et al., 2000; Würsig et al., 2000). The abundance estimate for the Clymene dolphin in the northern GOM is 17,355 individuals (Waring et al., 2004).

The Fraser's dolphin (*Lagenodelphis hosei*) has a worldwide distribution in tropical waters (Perrin et al., 1994b). Fraser's dolphins feed on fishes, cephalopods, and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Jefferson and Schiro, 1997). In the GOM, they occur in deeper waters off the continental shelf. The abundance estimate for this species in the northern GOM is 726 individuals (Waring et al., 2004).

The pantropical spotted dolphin (*Stenella attenuata*) is distributed in tropical and subtropical waters worldwide (Perrin and Hohn, 1994). It feeds on epipelagic fishes and cephalopods (Leatherwood and

Reeves, 1983; Jefferson et al., 1993). It is the most common cetacean in the oceanic northern GOM (Mullin et al., 1994b) and is found in the deeper waters off the continental shelf (Mullin et al., 1994c; Davis et al., 1998a and 2000). The abundance estimate for the pantropical spotted dolphin in the northern GOM is 91,321 individuals (Waring et al., 2004).

The Risso's dolphin (*Grampus griseus*) is distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves, 1983). They feed primarily on squid and secondarily on fishes and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily along the continental shelf and continental slope (Mullin and Fulling, 2004). The abundance estimate for the Risso's dolphin in the northern GOM is 2,169 individuals (Waring et al., 2004).

The rough-toothed dolphin (*Steno bredanensis*) occurs in tropical to warm temperate waters worldwide (Miyazaki and Perrin, 1994). This species feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily over the deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimate for the rough-toothed dolphin in the northern GOM (both oceanic waters and the outer continental shelf) is 2,223 individuals (Waring et al., 2004).

The spinner dolphin (*Stenella longirostris*) occurs worldwide in tropical and warm temperate waters (Perrin and Gilpatrick, 1994; Jefferson and Schiro, 1997), primarily in offshore, deepwater environments. They feed on mesopelagic fishes and squid (Würsig et al., 2000). In the northern GOM, they occur in deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimated for the spinner dolphin in the northern GOM is 11,971 individuals (Waring et al., 2004).

The striped dolphin (*Stenella coeruleoalba*) occurs in tropical to temperate oceanic waters (Perrin et al., 1994c). They feed primarily on small, mid-water squid and fishes, especially lanternfish (myctophid). In the GOM, they occur in the deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimate for the striped dolphin in the northern GOM is 6,505 individuals (Waring et al., 2004).

The false killer whale (*Pseudorca crassidens*) occurs worldwide in tropical and temperate oceanic waters (Odell and McClune, 1999). False killer whales primarily eat fish and cephalopods, but they have been known to attack other toothed whales (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, most sightings occur in deeper waters off the continental shelf (Davis and Fargion, 1996). The abundance estimate for the false killer whale in the northern GOM is 1,038 individuals (Waring et al., 2004).

The killer whale (*Orcinus orca*) has a worldwide distribution from tropical to polar waters (Dahlheim and Heyning, 1999). They feed on marine mammals, marine birds, sea turtles, cartilaginous and bony fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily in the deeper waters off the continental shelf (Davis and Fargion, 1996). The abundance estimate for the killer whale in the northern GOM is 133 individuals (Waring et al., 2004).

The melon-headed whale (*Peponocephala electra*) has a worldwide distribution in subtropical to tropical waters (Jefferson et al., 1992), feeding on cephalopods and fishes (Mullin et al., 1994a; Jefferson and Schiro, 1997). In the GOM, they occur in the deeper waters off the continental shelf (Mullin et al., 1994b). The abundance estimated for the melon-headed whale in the northern GOM is 3,451 individuals (Waring et al., 2004).

The pygmy killer whale (*Feresa attenuata*) occurs worldwide in tropical and subtropical waters (Ross and Leatherwood, 1994). Its diet includes cephalopods and fishes, though reports of attacks on other dolphins have been reported (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily in deeper waters off the continental shelf (Mullin and Fulling, 2004). The abundance estimate for the pygmy killer whale in the northern GOM is 408 individuals (Waring et al., 2004).

The short-finned pilot whale (*Globicephala macrorhynchus*) is distributed worldwide in tropical to temperate waters (Leatherwood and Reeves, 1983). They feed predominately on squid, with fishes being consumed occasionally (Würsig et al., 2000). In the GOM, they are most frequently sighted along the continental shelf and continental slope. The abundance estimate for the northern GOM is 2,388 individuals (Waring et al., 2004).

3.2.3.3. Factors Influencing Cetacean Distribution and Abundance

The distribution and abundance of cetaceans within the northern GOM is strongly influenced by various mesoscale oceanographic circulation patterns. These patterns are primarily driven by river discharge (primarily the Mississippi/Atchafalaya Rivers), wind stress, and the Loop Current and its derived circulation phenomena. Circulation on the continental shelf is largely wind-driven, with localized effects from freshwater (i.e., river) discharge. Beyond the shelf, mesoscale circulation is largely driven by the Loop Current in the eastern Gulf. Approximately once or twice a year, the Loop Current sheds anticyclonic eddies (also called warm-core rings). Anticyclones are long-lived, dynamic features that generally migrate westward and transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. These anticyclones, in turn, spawn cyclonic eddies (also called cold-core rings) during interaction with one another and upon contact with topographic features of the continental slope and shelf edge. These cyclones contain and maintain high concentrations of nutrients and stimulate localized production (Davis et al., 2000). In the north-central GOM, the relatively narrow continental shelf south of the Mississippi River Delta may be an additional factor affecting cetacean distribution (Davis et al., 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow also may be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity and may explain the persistent presence of aggregations of sperm whales within 31 mi (50 km) of the Mississippi River Delta in the vicinity of the Mississippi Canyon.

Tropical Weather

Tropical storms and hurricanes are a normal occurrence in the Gulf and along the coast. Generally, the impacts are localized and infrequent. However, in recent years the GOM has been extremely hard hit by several very powerful hurricanes. Few areas of the coast did not suffer some damage in 2004 and 2005. In 2004, Hurricane Ivan took a large toll on oil and gas structures and operations in the Gulf and caused widespread damage to the Alabama-Florida Panhandle coast. Hurricanes Katrina, Rita, and Wilma (2005) reached Category 5 strength in the GOM. These storms caused damage in all five of the Gulf Coast States and caused massive damage to structures and operations both offshore and on land. The actual impacts of these storms on the marine mammals in the Gulf have not yet been determined and, for the most part, may remain very difficult to quantify. Examples of impacts that may have affected species include oil, gas, and chemical spills from damaged and destroyed structures and vessels (though no major oil spills were reported, many lesser spills are known to have occurred), increased trash and debris in both offshore and inshore habitats, and increased runoff and silting from wind and rain. These impacts are expected to be temporary. Generally, the offshore species and the offshore habitat are not expected to have been severely affected in the long term. However, the seasonal occurrence of impacts from hurricanes is impossible to predict.

3.2.4. Sea Turtles

Of the seven or eight extant species of sea turtles, five are known to inhabit the waters of the GOM (Pritchard, 1997): the leatherback, green turtle, hawksbill, Kemp's ridley, and loggerhead (**Table 3-5**). These five species are all highly migratory, and no individual members of any of the species are likely to be year-round residents of the analysis area. Individual animals will make migrations into nearshore waters as well as other areas of the North Atlantic Ocean, GOM, and the Caribbean Sea.

Natural disturbances such as hurricanes can cause significant destruction of nests and topography of nesting beaches (Pritchard, 1980; Ross and Barwani, 1982; Witherington, 1986). Tropical storms and hurricanes are a normal occurrence in the Gulf and along the coast. Generally, the impacts have been localized and infrequent. However, in the last two years the GOM has been extremely hard hit by very powerful hurricanes. Few areas of the coast have not suffered some damage in 2004-2005, and activities in the Gulf have also been severely impacted. In 2004, Hurricane Ivan took a large toll on oil and gas structures and operations in the Gulf and caused widespread damage to the Alabama-Florida Panhandle coast. In 2005, Hurricanes Katrina, Rita, and Wilma reached Category 5 strength in the GOM. These storms caused damage to all five of the Gulf Coast States. The actual impacts of these storms on the animals in the Gulf, and the listed species and critical habitat in particular, have not yet been determined and, for the most part, may remain very difficult to quantify. However, some impacts, such as loss of beach habitat, are known to have occurred and will impact sea turtles that would have used those areas for nesting beaches.

3.2.4.1. Leatherback Sea Turtle

The leatherback is the most abundant sea turtle in waters over the northern GOM continental slope (Mullin and Hoggard, 2000). Leatherbacks appear to spatially use both continental shelf and slope habitats in the Gulf (Fritts et al., 1983b; Collard, 1990; Davis and Fargion, 1996). Recent surveys suggest that the region from Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Mullin and Hoggard, 2000). Temporal variability and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. Leatherbacks have been frequently sighted in the GOM during both summer and winter (Mullin and Hoggard, 2000).

Species/Critical Habitat Description

The leatherback sea turtle was listed as endangered on June 2, 1970 (35 FR 8491). Leatherback distribution and nesting grounds are found circumglobally and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, and the GOM (Ernst et al., 1994). Adult leatherbacks forage in temperate and subpolar regions from 71°N. to 47°S. latitude in all oceans and undergo extensive migrations between 90°N. and 20°S. latitude to and from the tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (USDOC, NMFS, 2001). Female leatherbacks nest from the southeastern U.S. to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic. The most significant nesting beaches in the Atlantic, and perhaps in the world, are in French Guiana and Suriname (USDOC, NMFS, 2001a).

The leatherback is the largest and most pelagic of sea turtles. The average curved carapace length for adults is 155 cm (61 in) and weights from worldwide populations range from 200 to 700 kg. Adults may attain weights up to and exceeding 1,000 kg and reach lengths of 1.9 m (6.2 ft). The leatherback forages widely throughout the water column from the surface to great depths throughout tropical and temperate oceans of the world. An adult leatherback was reported, by extrapolation of data, to achieve a maximum dive of 1,300 m (4,265 ft) (Eckert et al., 1989). The distribution of leatherbacks appears to be dependent upon the distribution of their gelatinous prey (Leary, 1957), consisting mostly of scyphomedusae (jellyfish) and pelagic tunicates. Leatherbacks typically lay a clutch of approximately 100 eggs within a nest cavity, requiring approximately 60 days of incubation until pipping. Hatchlings average 61.3 mm long and 44.4 g in mass. Neonate leatherbacks are the most active sea turtle species, crawling immediately across the beach to the sea upon emergence and swimming both day and night for at least 6 days after entering the surf (Wyneken and Salmon, 1992).

Critical habitat for the leatherback includes the waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands (U.S.V.I.). There is no critical habitat designation for the leatherback sea turtle in the GOM.

Life History

The leatherback is the largest living turtle and it ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (USDOC, NMFS and USDOI, FWS, 1992). Adult leatherbacks forage in temperate and subpolar regions from 71°N. to 47°S. latitude in all oceans and undergo extensive migrations to and from tropical nesting beaches between 90°N. and 20°S. latitude. Female leatherbacks nest from the southeastern U.S. to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic, with nesting occurring as early as late February or March. When they leave the nesting beaches, leatherbacks move offshore but eventually utilize both coastal and pelagic waters. Very little is known about the pelagic habits of the hatchlings and juveniles, and they have not been documented to be associated with the sargassum areas as are other species. Leatherbacks are deep divers, with estimated dives to depths in excess of 1,000 m (3,281 ft) (Eckert et al., 1989), but they may come into shallow waters if there is an abundance of jellyfish nearshore.

Although leatherbacks are a long-lived species (>30 years), they are somewhat faster to mature than loggerheads, with an estimated age at sexual maturity reported of about 13-14 years for females and an estimated minimum age at sexual maturity of 3-6 years, with 9 years reported as a likely minimum and 19 years as a likely maximum (Zug and Parham, 1996). They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years. During each nesting, females produce 100 eggs or more in each clutch and, thus, can produce 700 eggs or more per nesting season (Schultz, 1975).

Leatherback sea turtles feed primarily on jellyfish as well as cnidarians and tunicates. They are also the most pelagic of the turtles, but they have been known to enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated.

Population Dynamics

Leatherbacks are widely distributed throughout the oceans of the world and are found in waters of the Atlantic, Pacific, Caribbean, and the GOM (Ernst and Barbour, 1972). A population estimate of greater than or equal to 34,500 females (26,200-42,900) was made by Spotila et al. (1996), along with a claim that the species as a whole was declining and local populations were in danger of extinction (USDOC, NMFS, 2001). Genetic analyses of leatherbacks to date indicate that within the Atlantic basin significant genetic differences occur between St. Croix (U.S.V.I.) and mainland Caribbean populations (Florida, Costa Rica, Suriname/French Guiana) and between Trinidad and the mainland Caribbean populations (Dutton et al., 1999), leading to the conclusion that there are at least three separate subpopulations of leatherbacks in the Atlantic. The primary leatherback nesting beaches occur in French Guiana, Suriname, and Costa Rica in the western Atlantic, and in Mexico in the eastern Pacific. Recent declines have been seen in the number of leatherbacks nesting worldwide (USDOC, NMFS and USDOI, FWS, 1992). Adult mortality has increased significantly from interactions with fishery gear (Spotila et al., 1996). The Pacific population is in a critical state of decline, now estimated to number less than 3,000 total adult and subadult animals (Spotila et al., 2000). The status of the Atlantic population is less clear. In 1996, it was reported to be stable, at best (Spotila et al., 1996), but numbers in the western Atlantic at that time were reported to be on the order of 18,800 nesting females. The western Atlantic population currently numbers about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the eastern Atlantic, off Africa (numbering 4,700) have remained consistent with numbers reported by Spotila et al. (1996).

The nesting aggregation in French Guiana has been declining annually at about 15 percent since 1987. From 1979 to 1986, the number of nests was increasing at about 15 percent annually. The number of nests in Florida and the U.S. Caribbean has been increasing at about 10.3 and 7.5 percent, respectively, per year since the early 1980's, but the magnitude of nesting is much smaller than that along the French Guiana coast (USDOC, NMFS, 2001). In summary, the conflicting information regarding the status of Atlantic leatherbacks makes it difficult to conclude whether or not the population is currently in decline, numbers at some nesting sites are up, while at others they are down.

Status and Distribution

Leatherback sea turtles are susceptible to ingestion of marine debris (Balazs, 1985; Fritts, 1982; Lutcavage et al., 1997; Mrosovsky, 1981; Shoop and Kenney, 1992). Poaching of eggs and animals still occurs. In the U.S.V.I., four of five strandings in St. Croix were the result of poaching (Boulon, 2000).

Leatherbacks may become entangled in longline gear (USDOC, NMFS, 2001; Part III, Chapter 7), buoy lines, lobster pot lines (Prescott, 1988), and trawl fisheries (Marcano and Alio, 2000). During the period 1977-1987, 89 percent of the 57 stranded adult leatherbacks were the result of entanglement (Prescott, 1988), and during the period 1990-1996, 58 percent of the 59 stranded adult leatherbacks showed signs of entanglement. Leatherback sea turtles also are vulnerable to capture in gillnets (Goff et al., 1994; Castroviejo et al., 1994; Chevalier et al., 1999; Lagueux, 1998; Eckert and Lien, 1999).

Of the Atlantic turtle species, leatherback turtles seem to be the most susceptible to entanglement. This susceptibility may be the result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the lightsticks used to attract target species in the longline fishery. The observed take of leatherbacks by the Atlantic pelagic longline fishery during 1992 through 1999 was 263 turtles. When extrapolated for the entire Atlantic fishery, the estimated number of leatherbacks caught on longlines was 6,363 turtles. Most of the caught turtles were expected to be alive and released. Of the 6,363 estimated turtles caught, 88 (1.4%) were expected to be dead (USDOC, NMFS, 2001).

According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992 and 1999, of which 88 were discarded dead (USDOC, NMFS, 2001). However, the U.S. fleet accounts for a small portion (5%-8%) of the hooks fished in the Atlantic Ocean compared with other nations, including Taipei, Brazil, Trinidad, Morocco, Cyprus, Venezuela, Korea, Mexico, Cuba, United Kingdom, Bermuda, People's Republic of China, Grenada, Canada, Belize, France, and Ireland (Carocci and Majkowski, 1998). Reports of incidental takes of turtles are incomplete for many of these nations (USDOC, NMFS, 2001; see Part II, Chapter 5, page 162 for a complete description of take records). Adding up the underrepresented observed takes per country per year of 23 actively fishing countries would likely result in estimates of thousands of sea turtles taken annually over different life stages.

3.2.4.2. Green Sea Turtle

The Florida breeding population of the green sea turtle is listed as endangered. Green sea turtles are found throughout the GOM. They occur in small numbers over seagrass beds along the south of Texas and the Florida Gulf Coast. Reports of green turtles nesting along the Gulf Coast are infrequent.

Species/Critical Habitat Description

Federal listing of the green sea turtle occurred on July 28, 1978 (43 FR 32808), with all populations listed as threatened except for the breeding populations of Florida and Pacific coast of Mexico, which are endangered. The complete nesting range of the green turtle within the NOAA Fisheries Service, Southeast Region includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina and at the U.S.V.I. and Puerto Rico (USDOC, NMFS and USDOI, FWS, 1991a). Principal U.S. nesting areas for green turtles are in eastern Florida, predominantly Brevard through Broward Counties (Ehrhart and Witherington, 1992). Regular green turtle nesting also occurs on St Croix, U.S.V.I., and on Vieques, Culebra, Mona, and the main island of Puerto Rico (Mackay and Rebholz, 1996).

Critical habitat for the green sea turtle has been designated for the waters surrounding Isla Culebra, Puerto Rico, and its associated keys.

Life History

Green sea turtle mating occurs in the waters off the nesting beaches. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12- to 14-day intervals. Mean clutch size is highly variable among populations but averages 110-115. Females usually have 2-4 or more years between breeding seasons, while males may mate every year (Balazs, 1983). After hatching, green sea turtles go through a post-hatchling pelagic stage where they are associated with drift lines of algae and other debris.

Green turtle foraging areas in the southeast U.S. include any neritic waters having macroalgae or seagrasses near mainland coastlines, islands, reefs, or shelves, and any open-ocean surface waters, especially where advection from wind and currents concentrates pelagic organisms (Hirth, 1997; USDOC, NMFS and USDOI, FWS, 1991a). Principal benthic foraging areas in the region include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty, 1984; Hildebrand, 1982; Shaver, 1994a and b), the GOM off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr, 1957; Carr, 1984), Florida Bay and the Florida Keys (Schroeder and Foley, 1995), the Indian River Lagoon System, Florida (Ehrhart, 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Wershoven and Wershoven, 1992; Guseman and Ehrhart, 1992). Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs. Age at sexual maturity is estimated to be between 20 and 50 years (Balazs, 1982; Frazer and Ehrhart, 1985).

Green sea turtles are primarily herbivorous, feeding on algae and seagrasses, but they also occasionally consume jellyfish and sponges. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available.

Population Dynamics

The vast majority of green turtle nesting within the southeast U.S. occurs in Florida. In Florida from 1989 to 1999, green turtle abundance from nest counts ranged between 109 and 1,389 nesting females per year (Meylan et al., 1995); estimates assume 4 nests per female per year (Johnson and Ehrhart, 1994). High biennial variation and a predominant 2-year remigration interval (Witherington and Ehrhart, 1989; Johnson and Ehrhart, 1994) warrant combining even and odd years into 2-year cohorts. This gives an estimate of total nesting females that ranged between 705 and 1,509 during the period 1990-1999. It is important to note that, because methodological limitations make the clutch frequency number (4 nests/female/year) an underestimate (by as great as 50%), a more conservative estimate is 470-1,509 nesting females in Florida between 1990 and 1999. In Florida during the period 1989-1999, the numbers of green turtle nests by year show no trend. However, odd-even year cohorts of nests do show a significant increase during the period 1990-1999.

It is unclear how greatly green turtle nesting in the whole of Florida has been reduced from historical levels, although one account indicates that nesting in Florida's Dry Tortugas may now be only a small fraction of what it once was (Audubon, 1926; Dodd, 1981). Total nest counts and trends at index beach sites during the past decade suggest that green turtles that nest within the southeast U.S. are recovering and have only recently reached a level of approximately 1,000 nesting females. There are no reliable estimates of the number of green turtles inhabiting foraging areas within the southeast U.S., and it is likely that green turtles foraging in the region come from multiple genetic stocks. These trends are also uncertain because of a lack of data. However, there is one sampling area in the region with a large time series of constant turtle-capture effort that may represent trends for a limited area within the region. This sampling area is at an intake canal for a power plant on the Atlantic coast of Florida where 2,578 green turtles have been captured during the period 1977-1999 (Florida Power and Light, 2000a). At the power plant, the annual number of immature green turtle captures (minimum straight-line carapace length <85 cm (33 in)) has increased significantly during the 23-year period.

The status of immature green turtles foraging in the southeast U.S. might also be assessed from trends at nesting beaches where many of the turtles originated, principally, Florida, Yucatán, and Tortuguero. Trends at Florida beaches are presented above. Trends in nesting at Yucatán beaches cannot be assessed because of irregularity in beach survey methods over time. Trends at Tortuguero (20,000-50,000 nests/year) show a significant increase in nesting during the period 1971-1996 (Bjorndal et al., 1999).

Status and Distribution

The principal cause of past declines and extirpations of green turtle assemblages has been the over-exploitation of green turtles for food and other products. Adult green turtles and immatures are still exploited heavily on foraging grounds off Nicaragua and to a lesser extent off Colombia, Mexico, Panama, Venezuela, and the Tortuguero nesting beach (Carr et al., 1978; Nietschmann, 1982; Bass et al., 1998; Lagueux, 1998).

Significant threats on green turtle nesting beaches in the region include beach armoring, erosion control, artificial lighting, and disturbance. Armoring of beaches (e.g., seawalls, revetments, rip-rap, sandbags, and sand fences) in Florida, which is meant to protect developed property, is increasing and has been shown to discourage nesting even when armoring structures do not completely block access to nesting habitat (Mosier, 1998). Hatchling sea turtles on land and in the water that are attracted to artificial light sources may suffer increased predation proportional to the increased time spent on the beach and in the predator-rich nearshore zone (Witherington and Martin, 2000).

Green turtles depend on shallow foraging grounds with sufficient benthic vegetation. Direct destruction of foraging areas because of dredging, boat anchorage, deposition of spoil, and siltation (Coston-Clements and Hoss, 1983; Williams, 1988) may have considerable effects on the distribution of foraging green turtles. Eutrophication, heavy metals, radioactive elements, and hydrocarbons all may reduce the extent, quality, and productivity of foraging grounds (Frazier, 1980).

Pollution also threatens the pelagic habitat of juvenile green turtles. Older juvenile green turtles have also been found dead after ingesting seaborne plastics (Balazs, 1985). A major threat from manmade debris is the entanglement of turtles in discarded monofilament fishing line and abandoned netting (Balazs, 1985).

The occurrence of green turtle fibropapillomatosis disease was originally reported in the 1930's, when it was thought to be rare (Smith and Coates, 1938). At present, this disease is cosmopolitan and has been found to affect large numbers of animals in some areas, including Hawaii and Florida (Herbst, 1994; Jacobson, 1990; Jacobson et al., 1991). The tumors are commonly found in the eyes, occluding sight; the turtles are often discovered entangled in debris and are frequently infected secondarily.

Predation on sea turtles by animals other than humans occurs principally during the egg and hatchling stage of development (Stancyk, 1982). Mortality because of predation of early stages appears to be relatively high naturally, and the reproductive strategy of the animal is structured to compensate for this loss (Bjorndal, 1980).

Green turtles are often captured and drowned in nets set to catch fishes. Gillnets, trawl nets, pound nets (Crouse, 1982; Hillestad et al., 1982; National Research Council, 1990), and abandoned nets of many types (Balazs, 1985; Ehrhart et al., 1990) are known to catch and kill sea turtles. Green turtles also are taken by hook and line fishing. Collisions with power boats and encounters with suction dredges have killed green turtles along the U.S. coast and may be common elsewhere where boating and dredging activities are frequent.

3.2.4.3. Hawksbill Sea Turtle

Long-term trends in hawksbill nesting in Florida are unknown, although there are a few historical reports of nesting in south Florida and the Keys (True, 1884; Audubon, 1926; DeSola, 1935). No nesting trends were evident in Florida from 1979 to 2000; between 0 and 4 nests are recorded annually. The hawksbill has been recorded in all of the Gulf States. Nesting on Gulf beaches is extremely rare and one nest was documented at Padre Island in 1998 (Mays and Shaver, 1998). Pelagic-size individuals and small juveniles are not uncommon and are believed to be animals dispersing from nesting beaches in the Yucatán Peninsula of Mexico and farther south in the Caribbean (Amos, 1989). The majority of hawksbill sightings are reported from the sea turtle stranding network. Strandings from 1972 to 1989 were concentrated at Port Aransas, Mustang Island, and near the headquarters of the Padre Island National Seashore, Texas (Amos, 1989). Live hawksbills are sometimes seen along the jetties at Aransas Pass Inlet. Other live sightings include a 24.7-cm (9.7-in) juvenile captured in a net at Mansfield Channel in May 1991 (Shaver, 1994b) and periodic sightings of immature animals in the Flower Gardens National Marine Sanctuary.

Species/Critical Habitat Description

The hawksbill turtle was listed as endangered on June 2, 1970, and is considered critically endangered by the International Union for the Conservation of Nature (IUCN) based on global population declines of over 80 percent during the last three generations (105 years) (Meylan and Donnelly, 1999). In the western Atlantic, the largest hawksbill nesting population occurs in the Yucatán Peninsula of Mexico (Garduño-Andrade et al., 1999) with other important but significantly smaller nesting aggregations found in Puerto Rico, the U.S. Virgin Islands, Antigua, Barbados, Costa Rica, Cuba, and Jamaica (Meylan, 1999a). The species occurs in all ocean basins, although it is relatively rare in the eastern Atlantic and eastern Pacific, and absent from the Mediterranean Sea. Hawksbills have been observed on the coral reefs south of Florida, but they are also found in other habitats including inlets, bays, and coastal lagoons. A surprisingly large number of small hawksbills have also been encountered in Texas. The diet is highly specialized and consists primarily of sponges (Meylan, 1988), although other food items have been documented to be important in some areas of the Caribbean (van Dam and Diez, 1997; Mayor et al.; 1998; Leon and Diez, 2000). The lack of sponge-covered reefs and the cold winters in the northern Gulf likely prevent hawksbills from establishing a strong population in this area.

Critical habitat for the hawksbill turtle includes Mona and Monito Islands, Puerto Rico, and the waters surrounding these islands, out to 3 nmi. Mona Island receives protection as a Natural Reserve under the administration of the Puerto Rico Department of Natural Resources and Environment. The coral reef habitat and cliffs around Mona Island and nearby Monito Island are an important feeding ground for all sizes of post-pelagic hawksbills. Genetic research has shown that this feeding population is not primarily composed of hawksbills that nest on Mona, but instead includes animals from at least six different nesting aggregations, particularly the U.S. Virgin Islands and the Yucatán Peninsula (Mexico) (Bowen et al., 1996; Bass, 1999). Genetic data indicate that some hawksbills hatched at Mona use feeding grounds in waters of other countries, including Cuba and Mexico. Hawksbills in Mona waters appear to have limited home ranges and may be resident for several years (van Dam and Diez, 1998).

Life History

The life history of hawksbills consists of a pelagic stage that lasts from the time they leave the nesting beach as hatchlings until they are approximately 22-25 cm (9-10 in) in straight carapace length (Meylan, 1988), followed by residency in developmental habitats (foraging areas where immature individuals reside and grow) in coastal waters. Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hard-bottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over periods of time as great as several years (van Dam and Diez, 1998).

Hawksbills may undertake developmental migrations (migrations as immature turtles) and reproductive migrations that involve travel over hundreds or thousands of kilometers (Meylan, 1999b). Reproductive females undertake periodic (usually nonannual) migrations to their natal beach to nest. Movements of reproductive males are less well known, but they are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor. Females nest an average of 3-5 times per season, and the clutch size is up to 250 eggs (Hirth, 1980). Reproductive females may exhibit a high degree of nesting fidelity to their natal beaches.

Population Dynamics

Mona Island (Puerto Rico, 18º05'N. latitude, 67º57'W. longitude) has 7.2 km (4.5 mi) of sandy beach that host the largest known hawksbill nesting aggregation in the Caribbean Basin, with over 500 nests recorded annually from 1998 to 2000. The island has been surveyed for marine turtle nesting activity for more than 20 years; surveys since 1994 show an increasing trend. Increases are attributed to nest protection efforts in Mona and fishing reduction in the Caribbean. The U.S. Virgin Islands are also an important hawksbill nesting location. Buck Island Reef National Monument off St. Croix has been surveyed for nesting activity since 1987, where between 1987 and 1999, between 73 and 135 hawksbill nests had been recorded annually (Meylan and Donnelly, 1999). This population, although small, is considered to be stable. Nesting beaches on Buck Island experience large-scale beach erosion and accretion as a result of hurricanes, and nests may be lost to erosion or burial. Predation of nests by mongoose is a serious problem and requires intensive trapping. Hawksbill nesting also occurs elsewhere on St. Croix, St. John, and St. Thomas. Juvenile and adult hawksbills are common in the waters of the U.S. Virgin Islands. Immature hawksbills tagged at St. Thomas during long-term, in-water studies appeared to be resident for extended periods (Boulon, 1994). Tag returns were recorded from St. Lucia, the British Virgin Islands, Puerto Rico, St. Martin, and the Dominican Republic (Boulon, 1989; Meylan, 1999b).

The Atlantic coast of Florida is the only area in the U.S. where hawksbills nest on a regular basis, but four is the maximum number of nests documented in any year during 1979-2000. Nesting occurs as far north as Volusia County, Florida, and south to the Florida Keys, including Boca Grande and the Marquesas. Soldier Key in Miami-Dade County has had more nests than any other location, and it is one of the few places in Florida mentioned in the historical literature as having been a nesting site for hawksbills (DeSola, 1935). There is also a report of a nest in the late 1970's at nearby Cape Florida. It is likely that some hawksbill nesting in Florida goes undocumented because of the great similarity of the tracks of hawksbills and loggerheads. All documented records of hawksbill nesting from 1979 to 2000 took place between May and December except for one April nest in the Marquesas.

Twenty-four hawksbills were removed from the intake canal at the Florida Power and Light St. Lucie Plant in Juno Beach (St. Lucie County) during 1978-2000 (Florida Power and Light, 2000a). The animals ranged in size from 34.0- to 83.4-cm (13.4- to 32.8-in) straight carapace length and were captured in most months of the year. Immature hawksbills have been recorded on rare occasions in both the Indian River Lagoon (Indian River County) and Mosquito Lagoon (Brevard County). A 24.8-cm (9.8-in) hawksbill was captured on the worm reefs 200 m (656 ft) off the coast in Indian River County.

Records of hawksbills north of Florida are relatively rare, although several occurrences have been documented (Parker, 1996; Ruckdeschel et al., 2000; Epperly, 1996; Schwartz, 1976; Keinath and Musick, 1991).

Status and Distribution

Hawksbills are threatened by all the factors that threaten other marine turtles, including exploitation for meat, eggs, and the curio trade, loss or degradation of nesting and foraging habitats, increased human presence, nest depredation, oil pollution, incidental capture in fishing gear, ingestion of and entanglement in marine debris, and boat collisions (Lutcavage et al., 1997; Meylan and Ehrenfeld, 2000). The primary cause of hawksbill decline has been attributed to centuries of exploitation for tortoiseshell, the beautifully patterned scales that cover the turtle's shell (Parsons, 1972). International trade in tortoiseshell is now prohibited among all signatories of the Convention on International Trade in Endangered Species; however, some illegal trade continues, as does trade between nonsignatories.

3.2.4.4. Kemp's Ridley

The nearshore waters of the GOM are believed to provide important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles. Ogren (1988) suggests that the Gulf Coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern GOM. Stomach contents of Kemp's ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be shrimp fishery discards (Shaver, 1991). Analyses of stomach contents from sea turtles stranded on upper Texas beaches apparently suggest similar nearshore foraging behavior (Plotkin, 1995).

Species/Critical Habitat Description

The Kemp's ridley was listed as endangered on December 2, 1970. Internationally, the Kemp's ridley is considered the most endangered sea turtle. Kemp's ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico, Tamaulipas State. The species occurs mainly in coastal areas of the GOM and the northwestern Atlantic Ocean. Occasional individuals reach European waters. Adults of this species are usually confined to the GOM, although adult-sized individuals sometimes are found on the Eastern Seaboard of the U.S.

There is no designated critical habitat for the Kemp's ridley sea turtle.

Life History

Remigration of females to the nesting beach varies from annually to every 4 years, with a mean of 2 years (TEWG, 1998). Nesting occurs from April into July and is essentially limited to the beaches of the western GOM, near Rancho Nuevo in southern Tamaulipas, Mexico. The mean clutch size for Kemp's ridleys is 100 eggs/nest, with an average of 2.5 nests/female/season.

Juvenile/subadult Kemp's ridleys have been found along the Eastern Seaboard of the U.S. and in the GOM. Atlantic juveniles/subadults travel northward with vernal warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the cold (Lutcavage and Musick, 1985; Henwood and Ogren, 1987; Ogren, 1989). In the Gulf, juvenile/subadult ridleys occupy shallow, coastal regions. Ogren (1989) suggested that in the northern Gulf they move offshore to deeper, warmer water during winter. Studies suggest that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern GOM until cooling waters force them offshore or south along the Florida coast (Renaud, 1995). Little is known of the movements of the post-hatching, planktonic stage within the Gulf. Studies have shown the post-hatchling pelagic stage varies from 1 to 4 or more years, and the benthic immature stage lasts 7-9 years (Schmid and Witzell, 1997). The Turtle Expert Working Group (TEWG) (1998) estimates age at maturity to range from 7 to 15 years.

Stomach contents of Kemp's ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be shrimp fishery discards (Shaver, 1991). Pelagic stage, neonatal Kemp's ridleys presumably feed on the available sargassum and associated infauna or other epipelagic species found in the GOM.

Population Dynamics

Kemp's ridleys have a very restricted distribution relative to other sea turtle species. Data suggest that adult Kemp's ridley turtles are restricted somewhat to the GOM in shallow nearshore waters. Benthic immature turtles with a 20- to 60-cm (8- to 24-in) straight-line carapace length are found in nearshore coastal waters including estuaries of the GOM and the Atlantic, although adult-sized individuals sometimes are found on the Eastern Seaboard of the U.S. The post-pelagic stages are commonly found dwelling over crab-rich sandy or muddy bottoms. Juveniles frequent bays, coastal lagoons, and river mouths.

Of the seven extant species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the Rancho Nuevo beaches (Pritchard, 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand, 1963). By the early 1970's, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980's. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and the population is now increasing. Nesting at Tamaulipas and Veracruz increased from a low of 702 nests in 1985 to 1,930 nests in 1995and to 6,277 nests in 2000. The population model used by the TEWG (1998) projected that Kemp's ridleys could reach the Recovery Plan's intermediate recovery goal of 10,000 nesters by 2020 if the assumptions of age to sexual maturity and age-specific survivorship rates used in their model are correct.

Status and Distribution

The largest contributor to the decline of the ridley in the past was commercial and local exploitation, especially poaching of nests at the Rancho Nuevo site, as well as the GOM trawl fisheries. The advent of the Turtle Excluder Device (TED) regulations for trawlers and protections for the nesting beaches have allowed the species to begin to rebound. Many threats to the future of the species remain, including interactions with fishery gear, marine pollution, foraging habitat destruction, illegal poaching of nests, and the potential threats to nesting beaches from such sources as global climate change, development, and tourism pressures.

3.2.4.5. Loggerhead Sea Turtle

Loggerhead nesting along the Gulf Coast occurs primarily along the Florida Panhandle, although some nesting has been reported from Texas through Alabama as well (USDOC, NMFS and USDOI, FWS, 1991b). Loggerhead turtles have been primarily sighted in waters over the continental shelf, although many surface sightings of this species have also been made over the outer slope beyond the 1,000-m (3,281-ft) isobath. Sightings of loggerheads in waters over the continental slope suggest that they may be in transit through these waters to distant foraging sites or while seeking warmer waters during the winter. Although loggerheads are widely distributed during both summer and winter, their abundance in surface waters over the slope was greater during winter than in summer (Mullin and Hoggard, 2000).

Species/Critical Habitat Description

The loggerhead sea turtle was listed as a threatened species on July 28, 1978 (43 FR 32800). This species inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans, and within the continental U.S., and it nests from Louisiana to Virginia. The major nesting areas include coastal islands of Georgia, South Carolina, and North Carolina, and the Atlantic and Gulf Coasts of Florida, with the bulk of the nesting occurring on the Atlantic Coast of Florida. Developmental habitat for small juveniles is the pelagic waters of the North Atlantic and the Mediterranean Sea.

There is no critical habitat designated for the loggerhead sea turtle.

Life History

Loggerheads mate in late March through early June in the Southeastern U.S. Females emerge from the surf, excavate a nest cavity in the sand, and deposit a mean clutch size of 100-126 eggs. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests/nesting individual (Murphy and Hopkins, 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years but can vary from 1 to 7 years (Dodd, 1988). Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic gyre for as long as 7-12 years or more, but there is some variation in habitat use by individuals at all life stages. Turtles in this early life history stage are called pelagic immatures. Stranding records indicate that when pelagic immature loggerheads reach a 40- to 60-cm (16- to 24-in) straight-line carapace length they begin to recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and GOM.

Benthic immature loggerheads, the life stage following the pelagic immature stage, have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico. Large benthic immature loggerheads (70-91 cm, 28-36 in) represent a larger proportion of the strandings and in-water captures along the south and western coasts of Florida as compared with the rest of the coast. Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly et al., 1995; Keinath, 1993; Morreale and Standora, 1999; Shoop and Kenney, 1992) and migrate northward in spring. Past literature gave an estimated age at maturity of 21-35 years (Frazer and Ehrhart, 1985; Frazer et al.; 1994) and the benthic immature stage as lasting at least 10-25 years. However, in 2001 the NMFS Southeast Fisheries Science Center reviewed the literature and constructed growth curves from new data, estimating ages of maturity ranging from 20 to 38 years and benthic immature stage lengths from 14 to 32 years. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd, 1988). Subadult and adult loggerheads are primarily coastal and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

Population Dynamics

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerhead sea turtles concentrate their nesting in the north and south temperate zones and subtropics, but they generally do not nest in tropical areas of Central America, northern South America, and the Old World (Magnuson et al., 1990).

In the western Atlantic, most loggerhead sea turtles nest in the geographic area ranging from North Carolina to the Florida Panhandle. There are five western Atlantic subpopulations, divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29°N. latitude (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29°N. latitude on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez, 1990) (approximately 1,000 nests in 1998) (TEWG, 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year) (USDOC, NMFS, 2001). Natal homing of females to the nesting beach provides the barrier between these subpopulations, preventing recolonization with turtles from other nesting beaches.

Based on the available data, it is difficult to estimate the size of the loggerhead sea turtle population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989 to 1998 represent the best dataset available to index the population size of loggerhead sea turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females but may not reflect overall population growth rates. Given this caveat, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf Coasts ranged from 53,014 to 92,182 annually, with a mean of 73,751. On average, 90.7 percent of these nests were from the south Florida subpopulation, 8.5 percent were from the northern subpopulation, and 0.8 percent were from the Florida Panhandle nest sites. There is limited nesting throughout the GOM west of Florida, but it is not known to which subpopulation these nesting females belong.

The number of nests in the northern subpopulation from 1989 to 1998 was 4,370-7,887, with a 10-year mean of 6,247 nests. With each female producing an average of 4.1 nests in a nesting season, the average number of nesting females per year in the northern subpopulation was 1,524. The total nesting and nonnesting adult female population is estimated as 3,810 adult females in the northern subpopulation (TEWG, 1998 and 2000). The northern subpopulation, based on number of nests, has been classified as stable or declining (TEWG, 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate that the northern subpopulation produces 65 percent males, while the south Florida subpopulation is estimated to produce 80 percent females (USDOC, NMFS, 2001).

The southeastern U.S. nesting aggregation is of great importance on a global scale and is second in size only to the nesting aggregation on islands in the Arabian Sea off Oman (Ross, 1979; Ehrhart, 1989; USDOC, NMFS and USDOI, FWS, 1991b). The global importance of the southeast U.S. nesting aggregation of loggerheads is especially important because the status of the Oman colony has not been evaluated recently, but it is located in an area of the world where it is highly vulnerable to disruptive events such as political upheavals, wars, catastrophic oil spills, and lack of strong protections (Meylan et al., 1995).

Status and Distribution

Ongoing threats to the western Atlantic loggerhead populations include incidental takes from dredging, commercial trawling, longline fisheries, and gillnet fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; nest predation by native and nonnative predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease.

Loggerhead sea turtles face numerous threats from natural causes. The five known subpopulations of loggerhead sea turtles in the northwest Atlantic that nest in the southeastern U.S. are subject to fluctuations in the number of young produced annually because of natural phenomena, such as hurricanes, as well as human-related activities. There is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November) and the loggerhead sea turtle nesting season (March to November). Hurricanes can have potentially disastrous effects on the survival of eggs in sea turtle nests. In 1992, Hurricane Andrew affected turtle nests over a 90-mi length of coastal Florida. All of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton et al., 1994). On Fisher Island near Miami, Florida, 69 percent of the eggs did not hatch after Hurricane Andrew, likely because of an inhibition of gas exchange between the eggshell and the submerged nest environment resulting from the storm surge. Nests from the northern subpopulation were destroyed by hurricanes that made landfall in North Carolina in the mid- to late 1990's. Sand accretion and rainfall that result from these storms can appreciably reduce hatchling success. Recent, very active hurricane seasons, and particularly the 2004 and 2005 seasons that caused massive damage all along the Gulf Coast, have no doubt continued to greatly stress sea turtle populations in the area. These natural phenomena probably have significant, adverse effects on the size of specific year classes, particularly given the increasing frequency and intensity of hurricanes in the Caribbean Sea and northwest Atlantic Ocean.

3.2.5. Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Hall (1981) recognizes 16 subspecies of field mouse (*Peromyscus polionotus*), 8 of which are collectively known as beach mice. Of Gulf Coast subspecies, the Alabama, Choctawhatchee, St. Andrew, and Perdido Key, beach mice occupy restricted habitats in the mature coastal dunes of Florida and Alabama. All four mice are listed as endangered: the Alabama subspecies in Alabama, and the Perdido Key, St. Andrew, and Choctawhatchee subspecies in Florida (USDOI, FWS, 1987). Populations have fallen to levels approaching extinction. For example, in the late 1980's, estimates of total remaining beach mice were less than 900 for the Alabama beach mouse, about 80 for the Perdido Key beach mouse, and about 500 for the Choctawhatchee beach mouse. The Alabama, Perdido Key, and Choctawhatchee beach mice were listed as endangered in the 1980's. The St. Andrew beach mouse was not listed as endangered until 1998; it is the only listed subspecies without designated critical habitat. Continued monitoring of populations of all subspecies along the Gulf Coast between 1985 and the present indicates that approximately 52 km (32.3 mi) of coastal dune habitat are now occupied by the four listed subspecies (1/3 of historic range). Beach mice were listed because of the loss of coastal habitat from human development. The reduced distribution and numbers of beach mice have continued because of multiple habitat threats over their entire range (coastal development and associated human activities, military activities, coastal erosion, and weather). The *Federal Register* (2006) cites habitat loss as the primary cause for declines in populations of beach mice. Development of beachfront real estate along coastal areas and catastrophic alteration by hurricanes are the primary contributors to loss of habitat. Destruction of Gulf Coast sand dune ecosystems for commercial and residential development has destroyed about 60 percent of original beach mouse habitat (Holliman, 1983). Recent studies indicate that this continues to be a problem (Douglass et al., 1999; South Alabama Regional Planning Commission, 2001).

The inland extent of beach mouse habitat may vary depending on the configuration of the sand dune system and the vegetation present. There are commonly several rows of dunes paralleling the shoreline and within these rows there are generally three types of microhabitat. The first microhabitat is the frontal dunes, which are sparsely vegetated with widely scattered coarse grasses including sea oats (*Uniola paniculata*), bunch grass (*Andropogon maritimus*), and beach grass (*Panicum amarum* and *P. repens*), and with seaside rosemary (*Ceratiola ericoides*), beach morning glory (*Ipomoea stolonifera*), and railroad vine (*I. Pes-caprae*). The second microhabitat is the frontal dune grasses, a lesser component on the higher rear scrub dunes, which support growth of slash pine (*Pinus elliotti*), sand pine (*P. clausa*), and scrubby shrubs and oaks, including yaupon (*Ilex vomitoria*), marsh elder (*Iva sp*.), scrub oak (*Quercus myrtifolia*), and sand-live oak (*Q. virginiana* var. *maritima*). The third microhabitat is the interdunal areas, which contain sedges (*Cyperus sp*.), rushes (*Juncus scirpoides*), and salt grass (*Distichlis spicata)*.

Beach mice are restricted to the coastal barrier sand dunes along the Gulf. Optimal overall beach mouse habitat is currently thought to be comprised of a heterogeneous mix of interconnected habitats including primary dunes, secondary dunes, scrub dunes, and interdunal areas. Beach mice dig burrows mainly in the primary, secondary, and interior scrub dunes where the vegetation provides suitable cover. Most beach mouse surveys conducted prior to the mid-1990's were in primary and secondary dunes because the investigators assumed that these habitats are the preferred habitat of beach mice. A limited number of surveys in scrub dunes and other interior habitat resulted in less knowledge of the distribution and relative abundance there. In coastal environments, the terms "scrub" and "scrub dune" refer to habitat or vegetation communities adjacent to and landward of primary and secondary dune types where scrub oaks are visually dominant. Interior habitat can include vegetation types such as grass-like forbs (forbs are the herbs other than grasses). There is substantial variation in scrub oak density and cover within and among scrub dunes throughout ranges of beach mice. The variation, an ecological gradient, is represented by scrub oak woodland with a relatively closed canopy at one end of a continuum. At the other extreme of the gradient, scrub dunes are relatively open with patchy scrub ridges and intervening swales or interdunal flats dominated by herbaceous plants.

Beach mice feed nocturnally in the dunes and remain in burrows during the day. Their diets vary seasonally but consist mainly of seeds, fruits, and insects (Ehrhart, 1978; Moyers, 1996). Changes in the availability of foods result in changes in diets between seasons and account for variability of seasonal diets between years. Autumn diets of beach mice consist primarily of seeds and/or fruits of sea oats, evening primrose (*Oenothera humifusa*), bluestem (*Schizachyrium maritimum*), and dune spurge (*Chamaesyce ammannioides*). Sea oats and beach pea (Galactia sp.) dominate winter diets. Spring diets primarily consist of dune toadflax (*Linaria floridana*), yaupon holly (*Ilex vomitoria)*, seashore elder (*Iva imbricata*), and greenbrier (*Smilax sp.*). Summer diets are dominated by evening primrose, insects, dune toadflax, and ground cherry (*Physalis augustifolia*) (Moyers, 1996). Management practices designed to promote recovery of dune habitat, increase food sources, and enhance habitat heterogeneity may aid in recovery of beach mouse populations.

In wild populations, beach mice have an average life span of about nine months. Males and females reach adulthood and are able to reproduce at approximately 35 days of age. Females can nurse one litter while pregnant with another litter. From captive colonies we know that litter size is 1-8 with an average of four. Young are weaned in 2-3 weeks and are generally on their own 1-2 weeks later.

Hurricanes are a natural environmental phenomenon affecting the Gulf Coast, and beach mice have evolved and persisted in coastal dune habitats since the Pleistocene. Hurricanes are part of a repeated cycle of destruction, alteration, and recovery of dune habitat. The extensive coastal dune habitat that existed along the Gulf Coast before the fairly recent commerical and residential development allowed beach mice to survive even the most severe hurricane events to repopulate dune habitat as it recovered. Beach mice are affected by the passage of hurricanes along the northwest Florida and Alabama Gulf Coast. Since records on hurricane intensity began in 1885, a total of 32 hurricanes have struck northwest Florida within the historic ranges of the four Gulf Coast beach mouse subspecies (Williams and Duedall, 1997; Doering et al., 1994; Neumann et al., 1993). In addition, 22 hurricanes have made landfall along the coast of Alabama from 1851 to 2004 (USDOC, NOAA, National Hurricane Center, 2006).

Hurricanes generally produce damaging winds, storm tides and surges, and rain that erode barrier-island, peninsular, and mainland beaches and dunes. Following hurricanes, the dune system begins a slow natural repair process that may take 3-20 years, depending on the magnitude of dune loss (Salmon et al., 1982). During this period, sea oats and pioneer dune vegetation become established, collecting sand and building dunes. As the dunes grow and become stable, ot-her successional dune vegetation colonizes the area (Gibson and Looney, 1994), and beach mouse food sources and habitats are reestablished. The rate of recovery of food supplies for beach mice is variable with some areas adversely affected for an extended period of time by hurricane and post-hurricane conditions.

Tropical storms periodically devastate Gulf Coast sand dune communities, dramatically altering or destroying habitat, and either drowning beach mice or forcing them to concentrate on high scrub dunes where they are exposed to predators. How a hurricane affects beach mice depends primarily on its characteristics (winds, storm surge, rainfall), the time of year (midsummer is the worst), and where the eye crosses land (side of hurricane—clockwise or counterclockwise), population size, and storm impacts to habitat and food sources. The interior dunes and related access corridors may be essential habitats for beach mice following survival of a hurricane. For the three subspecies that have critical habitat areas (Alabama, Perdido Key, and Choctawhatchee beach mice), the major constituent elements that are known to require special management considerations or protection are dunes and interdunal areas and associated grasses and shrubs that provide food and cover (USDOI, FWS, 1985a and b).

Beach mice have existed in an environment subject to recurring hurricanes, but tropical storms and hurricanes are now considered to be a primary factor in the beach mouse's decline. It is only within the last 20-30 years that the combination of habitat loss due to beachfront development, isolation of remaining beach mouse habitat blocks and populations, and destruction of remaining habitat by hurricanes have increased the threat of extinction of several subspecies of beach mice.

The FWS reported considerable damage to 10 National Wildlife Refuges in Alabama, Mississippi, Louisiana, and the Panhandle of Florida caused by Hurricane Ivan in 2004 (USDOI, FWS, 2004). Perdido Key, Florida, was hit hard by Hurricane Ivan, and beach mouse dune habitat and populations were greatly reduced. Dune habitat is recovering and tracking data have shown that the mice are slowly expanding back into their previous range (Haddad, 2005). Hurricane Ivan adversely impacted an estimated 90-95 percent of primary and secondary dune habitat throughout the range of the Alabama beach mouse (USDOI, FWS, 2004a). Trapping data indicate that mice may have been extirpated from these low-lying areas (USDOI, FWS, 2004a). The mice take refuge on higher ground during severe storms. Approximately 3,460 ha (1,400 ac) of higher elevation scrub habitat did not appear to be inundated by storm surge from either Hurricanes Ivan or Katrina (U.S. Army Corps of Engineers, 2001; USFWS, 2004a and b, 2005; ENSR Corporation, 2004) but received moderate damage from salt spray and wind (Boyd et al. 2003; USDOI, FWS, 2004a). The worst damage from Hurricane Ivan occurred in Alabama to Bon Secour National Wildlife Refuge located west of Gulf Shores, Alabama along the Fort Morgan Peninsula. Major primary dunes at Bon Secour were almost completely destroyed and tons of debris washed up on the refuge.

Following Hurricane Opal in 1995, Swilling et al. (1998) reported higher Alabama beach mouse densities in the scrub than the foredunes nearly 1 year after the storm. As vegetation began to recover, however, the primary and secondary dunes were reoccupied by Alabama beach mice, and population densities surpassed those in the scrub in the fall and winter following the storm. Similar movement and habitat occupation patterns were observed following Hurricane Georges in 1998. Therefore, while Alabama beach mouse numbers and habitat quality in the frontal dunes ebb and flow in response to tropical storms, the higher elevation scrub habitat is important to mouse conservation as a more stable environment during and after storm events.

Reasons for Current Status

Beachfront development continues to be the greatest threat to beach mouse survival (Holler, 1991; Humphrey, 1992). Habitat reduction and fragmentation have affected the ability of beach mice to quickly recover following tropical storms. The combinations of habitat loss to beachfront development, isolation of remaining habitat blocks and beach mouse populations, and destruction of remaining habitat by hurricanes has increased the threat of extinction for the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice within the last 20-30 years (USFWS, 2006).

3.2.6. Coastal and Marine Birds

3.2.6.1. Nonendangered and Nonthreatened Species

The GOM is populated by both resident and migratory species of coastal and marine birds. They are herein separated into five major groups: diving birds, gulls/terns, shorebirds, passerines, wading birds, and waterfowl. Many species are mostly pelagic, and therefore rarely sighted nearshore. The remaining species are found within coastal and inshore habitats and are more susceptible to potential deleterious effects resulting from OCS-related activities (Clapp et al., 1982). Recent surveys indicate that Louisiana and Texas are among the primary states in the southern and southeastern U.S. for nesting colony sites and total number of nesting coastal and marine birds (Martin and Lester, 1991; Martin, 1991). Fidelity to these nesting sites varies from year to year along the Gulf Coast. Site abandonment along the northern Gulf Coast has often been attributed to habitat alteration and excessive human disturbance (Martin and Lester, 1991).

Diving birds are a diverse group. There are three main groups of diving birds: cormorants and anhingas (Pelecaniformes), loons (Gaviiformes), and grebes (Podicipediformes). Nesting diving birds in the Gulf include cormorants. The common diving birds in the northern GOM are listed with their main features in **Table 3-6.**

Gulls, terns, noddies, jaegers, and black skimmers make up the gull/tern group. Of these, colonies of laughing gulls, eight species of terns, and black skimmers nest in the Gulf (Martin and Lester, 1991; Pashley, 1991). Nesting terns include Caspian (*Sterna caspia),* royal (*S. maxima*), sandwich (*S. sandvicensis*), common (*S. hirundo*), Forster's (*S. forsteri*), least (*S. antillarum*), gull-billed (*Sterna nilotica*), and sooty (*S. fuscata*). All of the terns nesting in the GOM, as well as the Arctic tern (*S. paradisaea*), bridled tern (*S. anaethetus*), black tern (*Chlidonias niger*), brown noddy tern (*Anous stolidus*), and black noddy tern (*Anous minutus*), are found in blue water in the northern GOM (Cardiff, personal communication, 2006).

The first three species are known as "crested," with wing spans of 50 in, 41 in, and 34 in, respectively. The next two are called "medium-sized," with wing spans of 30 in and 31 in, respectively. Most of these species eat exclusively small fish and feed by plunge diving head-first from flight, often from a hovering position. Terns, like gannets and boobies (*Sula* spp.) and herons, are streamlined and have substantial size bills relative to prey size for "scooping," plunge diving, and (at least for the sulids and terns) underwater pursuit of fish. Exceptions to these feeding methods are the sooty tern (*S. fuscata*) (the only tropical species in the group) and gull-billed tern (*S. nilotica*). The two species pluck food from the water's surface. Gull-billed terns also pluck food from mud, and they feed mostly on insects and crabs. All seabirds are colonial nesting and all evolved from colonial land birds. Most land birds are not colonial nesters. Terns are smaller than other fish-eating seabirds and hence may be excluded from optimum fishing grounds by them. However, smaller birds have more flight power and can fly farther to search successfully for suboptimal fishing grounds.

Shorebirds are those members of the order Charadriiformes generally restricted to coastline and inland water margins (beaches, mudflats, etc.). The GOM shorebirds comprise five taxonomic families—Jacanidae (jacanas), Haematopodidae (oystercatchers), Recurvirostridae (stilts and avocets), Charadriidae (plovers), and Scolopacidae (sandpipers, snipes, and allies) (Hayman et al., 1986). All of them are solitary nesters. An important characteristic of almost all shorebird species is their strongly developed migratory behavior, with some shorebirds migrating from nesting places in the high Arctic tundra to the southern part of South America (Terres, 1991). Both spring and fall migrations take place in a series of "hops" to staging areas where birds spend time feeding heavily to store up fat for the sustained flight to the next staging area; many coastal habitats along the GOM are critical for such purposes. A recent study shows that all Arctic-breeding shorebirds (worldwide) avoid migration routes that require flying over barriers, including the Arctic Ocean itself, where landing and feeding cannot take place (Henningsson and Alerstam, 2005). Along the central Gulf Coast, 44 species of shorebirds have been recorded; only 6 nest in the area, the remaining are wintering residents and/or staging migrants (Pashley, 1991).

Passerine birds mostly migrate across the GOM each fall and spring and are protected along with other migrants under the Migratory Bird Treaty Act. A recent study of platforms as possible resting sites for birds crossing the Gulf was completed and is summarized as follows. Platforms for study were representative of the population of platforms at large, with respect to both structure and geography. Data suggest that the route for trans-Gulf migrants is influenced by the availability of tailwinds, with migrants attempting to minimize the time or energy expenditure required for crossing. Centers of offshore abundance as well as areas of eventual landfall varied in concert with synoptic weather. This pattern occurred despite the fact that synoptic weather was not necessarily without considerable variation along the trans-Gulf migration route and that not all birds of the same species conserve their migratory patterns. Very large flights (>25 million) occurred only in the three-week period from April 22 to May 13, probably related to the need to reach breeding grounds quickly because of the high feeding costs for egg production and brooding. Considerable fall migration was over the Western Gulf, where flight direction usually had a westerly component. Death of migrate by starvation was fairly common in spring. In accord with this result, as mentioned below, a recent sophisticated statistical study shows that all Arctic-breeding shorebirds (worldwide) avoid migration routes that require flying over barriers, including the Arctic Ocean itself, where landing and feeding cannot take place (Henningsson and Alerstam, 2005). Platforms have three primary proximate impacts on migrant birds: (1) they provide habitat for resting and refueling; (2) they induce nocturnal circulations; and (3) they result in some mortality through collisions. Platforms appeared to be suitable stopover habitats or most species, and most of the migrants that stopped over on platforms in highly nonrandom way and selected specific platform microhabitats (i.e., used alternative microhabitats nonrandomly) much in the same way that they select specific habitats during terrestrial stopovers. Preferred platform microhabitats were species specific and generally consistent between spring and fall. Platforms may facilitate the evolution of trans-Gulf migration strategies in certain species by providing "stepping stones" that allow incipient migrants to cross the Gulf successfully via a series of shorter flight. Cattle egrets colonized eastern North America only in the last half-century but have already become one of the most common species on platforms. Peregrine falcons are perhaps the most striking beneficiaries of platforms. This species, which formerly was near extinction, underwent a dramatic population recovery that was temporally coincident with the period of fastest expansion of the platform archipelago in the Gulf. Migrants sometimes arrived at certain platforms shortly after nightfall and proceeded to circle those platforms for variable periods ranging from minutes to hours. These nocturnal circulations clearly occurred because nocturnal migrants were attracted to platform light and tended to occur on overcast nights. Such circulation prevails when birds get inside the cone of light surrounding the platform and are reluctant to leave, seemingly becoming trapped by the surrounding "wall of darkness" and loss of visual cues to the horizon. Circulations put birds at risk for collision with the platform or with each other and result in non-useful expenditure of energy.

Although variations occur between species, most shorebirds begin breeding at one to two years of age and generally lay 3-4 eggs per year. Life histories of shorebirds contrast sharply with seabirds, and differential life histories may have profound influence on sensitivity to pollution, offshore OCS activities, and other dangers. The eggs are camouflaged, laid in scraps in the ground or little more, and hatch into precocious birds that leave the nests immediately and forage for a while with their parent before flying and feeding on their own. Shorebirds are solitary nesters but often roost and feed in flocks, frequently with mixed species. They may avoid colonial breeding because their food resources are not as patchy as for the offshore seabirds, which mostly nest colonially. Thus, they may not need to employ a few individual breeders to identify offshore patchy prey for consequent congregated predation by whole colonies or flocks of breeders. Alternatively, breeding shorebirds may be less susceptible to predators than offshore-breeding seabirds. For example, shorebirds can afford to lose eggs in their clutches of 2-4 eggs, whereas many seabirds lay only one egg per year. In addition, seabirds may lose hatchlings in their nests to avian or mammalian predators because the hatchlings remain for a time in the nest. This kind of mortality does not happen to shorebird hatchlings which are independent from hatching and leaving the nest as soon as they hatch. Shorebirds feed on a variety of marine and freshwater invertebrates and fish, and small amounts of plant life.

In addition, many of the overwintering shorebird species remain within specific areas throughout the season and exhibit between-year wintering site tenacity, at least when not disturbed by humans. These species may be especially susceptible to localized impacts resulting in habitat loss or degradation unless they move to more favorable habitats when disturbed by man.

Collectively, the following families of wading birds have representatives in the northern Gulf: Ardeidae (herons and egrets), Ciconiidae (storks), Threskiornithidae (ibises and spoonbills), and Gruidae (cranes). The common wading birds in the northern GOM are listed with their main features in **Table 3-7**. Wading birds are those birds that have adapted to living in shallow water. They have long legs that allow them to forage by wading into shallow water, while their long bills, usually accompanied by long necks, are used to probe under water or to make long swift strokes to seize fish, frogs, aquatic insects, crustaceans, and other prey (Terres, 1991). Seventeen species of wading birds in the Order Ciconiiformes are currently known to nest in the U.S., and all except the wood stork nest in the northern Gulf coastal region (Martin, 1991). Within the central Gulf Coast region, Louisiana supports the majority of nesting wading birds. Great egrets are the most widespread nesting species in the central Gulf region (Martin, 1991), while little blue herons, snowy egrets, and tricolored herons constitute the greatest number of coastal nesting pairs in the western Gulf Coast (Texas Parks and Wildlife Department, 1990). The term "marsh bird" is a general term for a bird that lives in or around marshes and swamps. Members of the Rallidae family (rails, including moorhens, gallinules, and coots) have compact bodies; therefore, they are labeled marsh birds and not wading birds. They are also elusive and rarely seen within the low vegetation of fresh and saline marshes, swamps, and rice fields, where they walk on long toes (Bent, 1926; National Geographic Society, 1983; Ripley and Beehler, 1985).

Waterfowl belong to the taxonomic order Anseriformes and include swans, geese, and ducks. A total of 36 species are regularly reported along the north-central and western Gulf Coast, consisting of 1 swan, 4 geese (i.e., greater white-fronted, snow, Canada, and Brant), 9 surface-feeding (dabbling) ducks (genus *Anis*; i.e., mallard, mottled, wigeon, northern pintail, northern shoveler, blue-winged teal, cinnamon teal, gadwall, and ruddy duck); 5 diving ducks (pochards), and 14 others (including the wood duck, whistling ducks, sea ducks, the ruddy duck, and mergansers) (Clapp et al., 1982; National Geographic Society, 1983; Madge and Burn, 1988). The common waterfowl in the northern GOM are listed with their main features in **Table 3-8**. Many species usually migrate from wintering grounds along the Gulf Coast to summer nesting grounds in the north. Waterfowl migration pathways have traditionally been divided into four parallel north-south paths, or "flyways," across the North American continent. The Gulf Coast serves as the southern terminus of both Central (Texas) and Mississippi (Louisiana, Mississippi, and Alabama) flyways. Waterfowl are highly social and possess a diverse array of feeding adaptations related to their habitat (Johnsgard, 1975).

3.2.6.2. Endangered and Threatened Species

The following coastal and marine bird species that inhabit or frequent the north-central and western GOM coastal areas are recognized by FWS as either endangered or threatened: piping plover, whooping crane, bald eagle, brown pelican, and least tern.

Piping Plover

The piping plover (*Charadrius melodus*) is a migratory shorebird that is endemic to North America. The piping plover breeds on shore of the northern Great Plains, in the Great Lakes, and along the Atlantic Coast (Newfoundland to North Carolina); and winters on the Atlantic and Gulf Coasts from North Carolina to Mexico and in the Bahamas West Indies. The final rule on critical habitat of piping plover was published July 10, 2001; there are 20 units of critical habitat in western Florida south to Tampa Bay, 3 areas in Alabama, 15 in Mississippi, 7 in Louisiana, and 37 in Texas (66 FR 132, pp. 36037-36086). Critical wintering habitat includes the land between mean lower low water and any densely vegetated habitat, which is not used by the piping plover. It has been hypothesized that specific wintering habitat, which includes coastal sand flats and mud flats in close proximity to large inlets or passes, may attract the largest concentrations of piping plovers because of a preferred prey base and/or because the substrate coloration provides protection from aerial predators due to chromatic matching, or camouflage (Nicholls and Baldassarre, 1990). This species remains in a precarious state given its low population numbers, sparse distribution, and continued threats to habitat throughout its range. Of the birds located on the U.S. wintering grounds during censuses of 1991 and 1996, about 89 percent were found on the Gulf Coast and 8 percent on the Atlantic Coast. Along the Gulf Coast, the highest numbers of wintering plovers occur along the Texas coast (1,333) (Haig and Plissner, 1993). Piping plovers begin arriving on the wintering grounds in July and keep arriving through September. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging. Primary prey for wintering plovers includes polychaete marine worms, various crustaceans, insects, and sometimes bivalve mollusks. They peck prey from on top of or just beneath the sediment. Foraging usually is on moist or wet sand, mud, or fine shell. In some cases, a mat of blue-green algae may cover this substrate. When not foraging, plovers can be found in aggressive encounters, roosting, preening, bathing, and moving among available habitat locations. The habitats used by wintering birds include beaches, mud flats, sand flats, algal flats, and washover passes (areas where breaks in the sand dunes result in an inlet). Wintering plovers are dependent on a mosaic of habitat patches and move among these patches depending on local weather and tidal conditions. In late February, piping plovers begin leaving the wintering grounds to migrate back to their breeding sites. Northward migration peaks in late March, and by late May most birds have left the wintering grounds. The migration of the piping plover is poorly understood. On the northern breeding grounds, river alteration and reservoir creation cause high water flow where birds once relied on exposed sand bars to breed. However, diversion of peak flows in northern nesting habitat is also harmful. The result is encroachment of vegetation usually kept under control by scour during high river flows.

Whooping Crane

The whooping crane (*Grus americana*) is an omnivorous, wading bird. The whooping crane formerly ranged from summer breeding grounds within the central Canadian provinces and northern prairie states to southern coastal wintering grounds from central Mexico to the Carolinas (Bent, 1926). Whooping cranes currently exist in three wild populations and at five captive locations (USDOI, FWS, 1994). The only self-sustaining wild population nests in the Northwest Territories and adjacent areas of Alberta, Canada, primarily within the boundaries of Wood Buffalo National Park (WBNP). These birds winter in coastal marshes and estuarine habitats along the Gulf Coast at Aransas National Wildlife Refuge (ANWR), Texas, and represent the majority of the world's population of free-ranging whooping cranes. Another wild flock was created with the transfer of wild whooping crane eggs from nests in the WBNP to be reared by wild sandhill cranes in an effort to establish a migratory, Rocky Mountains Population (USDOI, FWS, 1994). This population summers in Idaho, western Wyoming, and southwestern Montana and winter in the middle Rio Grande Valley, New Mexico. The third wild population is the first step in an effort to establish a nonmigratory population in Florida (USDOI, FWS, 1994). The December 1993 wild population was estimated at 160; the captive population contained 101 birds (USDOI, FWS, 1994).

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle that regularly occurs on the North American continent (USDOI, FWS, 1984). Its range extends from central Alaska and Canada to northern Mexico. The bulk of the bald eagle's diet is fish, though bald eagles will opportunistically take birds, reptiles, and mammals (USDOI, FWS, 1984). The historical nesting range of the bald eagle within the Southeast U.S. included the entire coastal plain and shores of major rivers and lakes. The current range is limited, with most breeding pairs occurring in Florida and Louisiana, and some in South Carolina, Alabama, and east Texas. One hundred twenty nests have been found in Louisiana; only 3 nests occurred within 5 mi of the coast (Patrick, written communication, 1997). The bald eagle was listed as endangered in 1967 in response to the declines due to DDT and other organochlorines that affected the species' reproduction (USDOI, FWS, 1984). Recovery may be slowed by human disturbance if it affects the abundance of preferable trees for nesting and perching. Preferred perch trees may be relatively large in diameter, height, surrounding percent forest cover, surrounding size of block of forest, height of surrounding canopy above the ground, height of perch above surrounding canopy, and size of the angle of open flight path to the perch (Buehler et al., 1992; Chandler et. al., 1995). For preferred nest trees, important features may be proximity to water (usually within 1/2 mile), a clear flight path to a close point on the water, an open view of the surrounding area and proximity to preferable perch trees. In July 1995, the FWS reclassified the bald eagle from endangered to threatened in the lower 48 states (*Federal Register*, 1995b).

Brown Pelican

The brown pelican (*Pelicanus occidentalis*) is one of two pelican species in North America. It feeds entirely upon fishes captured by plunge diving in coastal waters. Organochlorine pesticide pollution apparently contributed to the endangerment of the brown pelican. Organochlorines like DDT accumulate up the food web and reach their highest concentrations in predators such as the brown pelican. The pesticides interfere with calcium metabolism, causing reduced calcification of egg shells, and potentially allowing the eggs to be crushed under the weight of an incubating parent. In recent years, there has been a marked increase in brown pelican populations within the former range of the species. The population of brown pelicans and their habitat in Alabama, Florida, Georgia, North and South Carolina, and points northward along the Atlantic Coast were removed from the endangered species list in 1985; however, within the remainder of the range, which includes coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered (*Federal Register*, 1985b). Ten thousand nests and an estimated 25,000 adults were found in Louisiana (Patrick, written communication, 1997). The Louisiana Department of Wildlife and Fisheries submitted a request in March 1994 to the FWS to officially remove the eastern brown pelican from the endangered species list in Louisiana (Louisiana Dept. of Wildlife and Fisheries, 1994).

Least Tern

The least tern (*Sterna antillarum*) is the smallest North American tern. Three subspecies of New World least terns were recognized by the American Ornithologists' Union (1957). These are the interior least tern (*Sterna antillarum athalossus*), the eastern or coastal least tern (*S. antillarum antillarum*), and the California least tern (*S. antillarum browni*). According to the *Federal Register* (1985b), "Because of the taxonomic uncertainty of least tern subspecies in eastern North America, the [Fish and Wildlife] Service decides not to specify the subspecies in this final rule. Instead the Service designates as endangered the subspecies of least terns (hereinafter referred to as interior least tern) occurring in the interior of the U.S. [S. *antillarum athalossus*]." Least terns within 50 mi of the Gulf Coast are not are listed as endangered and will not be further analyzed here.

Effects of Hurricanes Katrina and Rita

Hurricanes Katrina and Rita have impacted avian habitats throughout the Gulf. Large areas of coastal wetlands have been converted to open-water habitat, potentially affecting avian species that used the wetlands for foraging, nesting, and as stopover points during migration (Gabe et al., 2005). Impacts to these habitats have the potential to result in population level impacts affecting both abundance and distribution of some species. For example, the coastal habitats that were significantly impacted in southeastern Louisiana and the Galveston Bay area of Texas support nesting by up to 15 percent of the world's brown pelicans and 30 percent of the world's sandwich terns (Hunt, 2006). Impacts to these habitats could reduce future nesting success and affect overall population levels of these species. Impacts to bottomland forest habitat along the Louisiana and Mississippi coasts represent further loss of avian habitat affecting many different species, while up to 70 percent of the cavity trees used by the endangered red-cockaded woodpecker at Big Branch March National Wildlife Refuge were destroyed (Hunt, 2006). The long-term effects of avian habitat loss because of these hurricanes is not known, and agencies such as FWS and USGS are implementing numerous studies and monitoring programs to determine the extent and magnitude of impacts to affected avian populations.

After Hurricane Rita, the Chenier Plain in western Louisiana was sampled for plant and animal food for neotropical migrant birds. Invertebrate food for these birds (mostly insects and spiders) was sampled.

Saltwater intrusion killed almost all crawfish being raised in ponds and killed freshwater vegetation there also; reptiles and especially amphibians were also killed by flooding saltwater moving inland. Brown pelican blood samples were taken immediately after Hurricane Katrina. Follow-up samples for contaminants that could impact reproductive function for other coastal and marine birds are planned pending funding (Fuller, personal communication, 2006; Harris, personal communication, 2006; Burrow, personal communication, 2006).

3.2.7. Endangered and Threatened Fish

3.2.7.1. Gulf Sturgeon

The Gulf sturgeon, a subspecies of the Atlantic sturgeon (*A. o. oxyrhynchus*), has a subcylindrical body embedded with bony plates (scutes), a greatly extended snout, ventral mouth with four anterior chin barbels, and a heterocercal tail (Valdykov, 1955; Valdykov and Greeley, 1963). Adults range from 1.8 to 2.4 m (5.9 to 7.9 ft) in length, with females attaining a greater length and mass than males.

The NOAA Fisheries Service and FWS listed the Gulf sturgeon as a threatened species on September 30, 1991. Subsequently, a recovery plan was developed to ensure the preservation and protection of Gulf sturgeon spawning habitat (USDOI, FWS and Gulf States Marine Fisheries Commission, 1995). Critical habitat was proposed June 6, 2002, in the *Federal Register* and was designated on April 18, 2003. Critical habitat is defined as specific geographic areas that are essential for the conservation of a threatened or endangered species and that may require special management consideration or protection. Fourteen geographic areas in the GOM rivers and tributaries were included in the critical habitat designation:

- Pearl and Bogue Chitto Rivers in Louisiana and Mississippi;
- Pascagoula, Leaf, Bowie (also referred to as Bouie), Big Black Creek, and Chickasawhay Rivers in Mississippi;
- Escambia, Conecuh, and Sepulga Rivers in Alabama and Florida;
- Yellow, Blackwater, and Shoal Rivers in Alabama and Florida;
- Choctawhatchee and Pea Rivers in Florida and Alabama;
- Apalachicola and Brothers Rivers in Florida; and
- Suwannee and Withlacoochee Rivers in Florida.

The critical habitat also includes portions of the following estuarine and marine areas:

- Lake Pontchartrain (east of the Lake Pontchartrain Causeway), Lake Catherine, Little Lake, The Rigolets, Lake Borgne, Pascagoula Bay, and Mississippi Sound systems in Louisiana and Mississippi, and sections of the adjacent State waters within the GOM;
- Pensacola Bay system in Florida;
- Santa Rosa Sound in Florida;
- nearshore GOM in Florida;
- Choctawhatchee Bay system in Florida;
- Apalachicola Bay system in Florida; and
- Suwannee Sound and adjacent State waters within the GOM in Florida.

The primary constituent elements of these designated areas that are considered essential for the conservation of the Gulf sturgeon include abundant food items; riverine spawning sites with appropriate substrates; riverine aggregation sites; a flow regime necessary for normal behavior, growth, and survival of all riverine life stages; water quality with the characteristics needed for normal behavior, growth, and viability of all life stages; sediment quality needed for normal behavior, growth, and viability of all life stages; and safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats. The critical habitat for Gulf sturgeon encompasses approximately 1,730 river miles (2,783 river km) and 2,333 mi^2 (6,042 km^2) of estuarine and marine habitat. Major shipping channels have been excluded in the critical habitat units.

The Gulf sturgeon is anadromous, with immature and mature fish participating in freshwater migrations. Gill netting and biotelemetry have shown that subadults and adults spend 8-9 months each year in rivers and 3-4 of the coolest months in estuaries or Gulf waters. The adult fish tend to congregate in deeper waters of rivers with moderate currents and sand and rocky bottoms. Seagrass beds with mud and sand substrates appear to be important marine habitats (Mason and Clugston, 1993). Individuals are long-lived, some reaching at least 42 years in age (Huff, 1975). Age at sexual maturity for females ranges from 8 to 17 years and for males ranges from 7 to 21 years (Huff, 1975).

Gulf sturgeon eggs are demersal (sink to the bottom) and adhesive (Vladykov and Greeley, 1963). Spawning occurs in freshwater over relatively hard and sediment-free substrates such as limestone outcrops and cut limestone banks, exposed limestone bedrock or other exposed rock, large gravel or cobble beds, soapstone, or hard clay (Fox and Hightower, 1998; Marchent and Shutters, 1996; Sulak and Clugston, 1999). Although fry and juveniles feed in the riverine environment, subadults and adults do not (Mason and Clugston, 1993; Sulak and Clugston, 1999).

Subadult and adult Gulf sturgeon spend cool months (October or November through March or April) in estuarine areas, bays, or in the GOM (Odenkirk, 1989; Clugston et al., 1995). Adult Gulf sturgeon likely overwinter in the GOM. Habitats used by Gulf sturgeon in the vicinity of the Mississippi Sound barrier islands tend to have a sand substrate and an average depth of 1.9-5.9 m (6.2-19.4 ft). Where estuary and bay unvegetated "mud" habitats have a preponderance of natural silts and clays supporting Gulf sturgeon prey, the Gulf sturgeon found there are assumed to be using these habitats for foraging.

Sulak and Clugston (1999) describe two hypotheses regarding where adult Gulf sturgeon may overwinter in the GOM to find abundant prey. The first hypothesis is that Gulf sturgeon spread along the coast in nearshore waters in depths less than 10 m (33 ft). The alternative hypothesis is that they migrate far offshore to the broad sedimentary plateau in water depths of 40-100 m (131-328 ft) west of the Florida Middle Grounds. Available data support the first hypothesis. Evaluation of tagging data has identified several nearshore GOM feeding migrations but no offshore GOM feeding migrations. Telemetry data documented Gulf sturgeon from the Pearl River and Pascagoula River subpopulations migrating from their natal bay systems to Mississippi Sound and moving along the barrier islands on both the island passes (Ross et al., 2001). Gulf sturgeon from the Choctawhatchee River, Yellow River, and Apalachicola River have been documented migrating in the nearshore GOM waters between Pensacola and Apalachicola Bay units (Fox et al., 2000). Telemetry data from the GOM mainly show sturgeon in depths of 6 m (19.8 ft) or less (Ross et al., 2001; Fox et al., 2000).

Gulf sturgeon occur in most major tributaries of the northeastern GOM from the Mississippi River east to Florida's Suwannee River, and in the central and eastern Gulf waters as far south as Charlotte Harbor (Wooley and Crateau, 1985). In Florida, Gulf sturgeon are still found in the Escambia, Yellow, Blackwater, Choctawhatchee, Apalachicola, Ochlockonee, and Suwannee Rivers (Reynolds, 1993). While little is known about the abundance of Gulf sturgeon throughout most of its range, population estimates have been calculated for the Apalachicola, Choctawhatchee, and Suwannee Rivers. The FWS calculated an average (from 1984 to 1993) 115 individuals (>45 cm (18 in) total length (TL)) over-summering in the Apalachicola River below Jim Woodruff Lock and Dam (USDOI, FWS, 1995). Preliminary estimates of the size of the Gulf sturgeon subpopulation in the Choctawhatchee River system are 2,000-3,000 fish over 61 cm (24 in) total length. The Suwannee River Gulf sturgeon population (i.e., fish >60 cm (24 in) TL and older than age 2) has been calculated recently at approximately 7,650 individuals (Sulak and Clugston, 1999). Although the size of the Suwannee River sturgeon population is considered stable, the population structure is highly dynamic as indicated by length frequency histograms (Sulak and Clugston, 1999). Strong and weak year-classes coupled with the regular removal of larger fish limit the growth of the Suwannee River population but stabilize the average population size (Sulak and Clugston, 1999).

The historic range of the Gulf sturgeon included nine major rivers and several smaller rivers from the Mississippi River, Louisiana, to the Suwannee River, Florida, and the marine waters of the Central and Eastern GOM, south to Tampa Bay (Wooley and Crateau, 1985; USDOI, FWS, 1995). Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic occurrences have been recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay (Wooley and Crateau, 1985; Reynolds, 1993).

Five genetically-based stocks have been identified by NOAA Fisheries Service and FWS: (1) Lake Pontchartrain and Pearl River; (2) Pascagoula River; (3) Escambia and Yellow Rivers; (4) Choctawhatchee River; and (5) Apalachicola, Ochlockonee, and Suwannee Rivers. Mitochondrial DNA analyses of individuals from subpopulations indicate that adults return to natal river areas for feeding as well as spawning (Stabile et al., 1996).

Until recently only two spawning sites were known, both in the Suwannee River in Florida. Eggs have now been discovered in six locations within the Choctawhatchee River system in Florida and Alabama (Fox and Hightower, 1998). In spring, large subadults and adults that migrate from the estuaries or the Gulf into major river passes feed primarily on lancelets, brachiopods, amphipods, polychaetes, and globular molluscs. Small sturgeon that remain in river passes during spring feed on amphipods, shrimp, isopods, oligochaetes, and aquatic insect larvae (Clugston, 1991). During the riverine stage, adults cease feeding, undergo gonadal maturation, and migrate upstream to spawn. Spawning occurs in freshwater reaches of the river, over coarse substrate in deep areas or holes with hard bottoms and where some current is present (Sulak and Clugston, 1998; Fox et al., 2000). Females lay large numbers of eggs. A large female was reported to have the capability of producing of 275,000-475,000 eggs (Chapman at al., 1993). These eggs are adhesive and will attach to rocks, vegetation, or other objects. They hatch in about 1 week depending upon the temperature of the water.

Fisheries scientists interrupt migrating Gulf sturgeon in the rivers and estuaries by capture with nets suspended from floats in the rivers and river mouths. Gill nets with mesh wide enough not to close the very large opercula are used. No capture or tracking is feasible in the open Gulf just when the fish migrate into it because cold fronts come every 2-3 days, with up to 9-ft seas. Conditions are dangerous for the size of vessel required, and the paths traveled in the open Gulf cannot be followed beyond the estuaries. Thus, the offshore winter distribution of Gulf sturgeon relative to the location of the activities under the proposed action is unknown. However, there have been no reported catches of this species in Federal waters (Sulak, personal communication, 1997).

Sturgeon are bottom suction feeders that have ventrally located, highly extrusible mouths. The sturgeon head is dorsoventrally compressed with eyes dorsal so benthic food under the sturgeon's mouth will not be visible. However, they have taste barbels, like catfish, to detect prey. The barbels are also useful for feeding in high-order streams when they are muddy. However, Gulf sturgeon are common in clear water streams also. The barbels may locate food at night when visibility of prey is low from any direction. Fishes that forage by taste are opportunistic feeders because smell is much more discriminating than taste. Another adaptation of sturgeon to mainstem rivers and offshore waters is mobility (an adaptation to the large habitat scale). High fecundity (egg number) facilitates wide dispersal, a major adaptation to the high variance of habitat quality resulting from diverse habitats and dynamic nature of mainstems of watersheds.

The decline of the Gulf sturgeon is believed to be due to overfishing and habitat destruction, primarily the damming of coastal rivers and the degradation of water quality (Barkuloo, 1988). In the late 19th century and early 20th century, the Gulf sturgeon supported an important commercial fishery, providing eggs for caviar, flesh for smoked fish, and swim bladders for isinglass, a gelatin used in food products and glues (Carr, 1983). Dams and sill construction mostly after 1950 restricted access to historic spawning areas (Wooley and Crateau, 1985) exacerbating habitat loss, and overfishing resulted in the decline of the Gulf sturgeon throughout most of the 20th century. In several rivers throughout its range, dams have severely restricted sturgeon access to historic migration routes and spawning areas. Dredging and other navigation maintenance, possibly including lowering of river elevations and elimination of deep holes and altered rock substrates, may have adversely affected Gulf sturgeon habitats (Wooley and Crateau, 1985). Contaminants, both agricultural and industrial, may also be a factor in their decline. Organochlorines have been documented to cause reproductive failure in the Gulf sturgeon, reduced survival of young, or physiological alterations in other fish (White et al., 1983). In addition, Gulf sturgeon appear to be natal spawners with little, if any, spawning from other riverine populations.

Today, the greatest habitat threat to sturgeon is the damming of coastal rivers. Sturgeon cannot pass through the lock and dam systems to reach spawning areas. Dredging, desnagging, and spoil deposition associated with channel maintenance and improvement also present a threat to sturgeon spawning habitat. Poor water quality because of pesticide runoff, heavy metals, and industrial contamination may be affecting sturgeon populations. Habitat loss continues to pose major threats to the recovery of the species.

Natural phenomenon such as tropical storms and hurricanes occur along the Gulf Coast with varying frequency and intensity between years. Although these are usually localized and sporadic, the 2004-2005 storm seasons brought major and repeated damage to the Gulf Coast area. The effects from Hurricane Katrina (2005) are still being assessed. The impacted area included a large portion of the designated critical habitat and known locations of Gulf sturgeon. The sturgeon are upstream in freshwater riverine habitats during the tropical weather season. This may give the estuarine and marine areas time to recover from hurricane impacts before the sturgeon move downstream. For instance, massive runoff due to flooding rains and swollen tributaries could cause a sharp increase in toxic contaminants in estuarine habitats. However, spreading and dilution should mitigate any threat to sturgeon very quickly. By the time the downstream migration occurs, conditions should have returned to near normal. The flooding and subsequent "unwatering" of New Orleans in the fall of 2005 created concern for any sturgeon that might have been in the areas of Lake Pontchartrain where those contaminated flood waters were pumped. The COE noted in their EA that temporary impacts to Gulf sturgeon may have resulted as a part of the unwatering activities related to the pumping of floodwaters into Lake Pontchartrain. Impacts due to the quantity and quality of the floodwaters may have caused some sturgeon to seek forage and resting areas in other more undisturbed locations of the lake. It was expected that any sturgeon displaced returned to the area once the unwatering activities ceased (USACE, 2005a). The COE also noted that the emergency procedures permitted in the Panama City, Florida, aftermath of Hurricane Ivan may have created temporary impacts to species including the Gulf sturgeon, but that the emergency procedures did not adversely impact the species (USACE, 2005b). After Hurricane Katrina, there were reports of fish kills and at least one confirmed report of a dead Gulf sturgeon due to low oxygen in the water from organic input from leaf litter and other sources such as raw sewage and untreated effluent (Cummins, 2005). Many municipalities or sources of discharges lost power and/or were flooded and were likely a source of contaminant discharge. The hurricane impacts have not yet been fully assessed for Gulf sturgeon but are generally believed to be temporary (Baker, personal communication, 2006).

3.2.8. Fisheries

3.2.8.1. Fish Resources

Ichthyoplankton

Most fishes inhabiting the GOM, whether benthic or pelagic as adults, have pelagic larval stages. For various lengths of time (10-100 days depending on the species), these pelagic eggs and larvae become part of the planktonic community. Variability in survival and transport of pelagic larval stages is thought to be an important determinant of future year-class strength in adult populations of fishes and invertebrates (Underwood and Fairweather, 1989; Doherty and Fowler, 1994). In general, the distribution of fish larvae depends on spawning behavior of adults, hydrographic structure and transport at a variety of scales, duration of the pelagic period, behavior of larvae, and larval mortality and growth (Leis, 1991). Larval fishes are highly dependent on zooplankton until they can feed on larger prey.

Ichthyoplankton sampling at a regional scale in the GOM began in the early 1970's with routine surveys for king and Spanish mackerel larvae (Wollam, 1970; Dwinell and Futch, 1973). Houde et al. (1979) conducted major surveys of ichthyoplankton in the Eastern GOM from 1972 to 1974. Finucane et al. (1977) collected eggs and ichthyoplankton from areas off the Texas continental shelf over a three-year period (1975-1977) as part of the South Texas Outer Continental Shelf Studies. In 1982, the first comprehensive surveys of the Southeastern Area Monitoring and Assessment Program (SEAMAP) began collecting larval fishes in the GOM from a grid of sampling stations encompassing the entire northern GOM. Since SEAMAP's inception, the goal of plankton activities in the GOM has been to collect data on the early life stages of fishes and invertebrates that will complement and enhance the fishery independent data gathered on the adult life-stage. This continuing survey remains the only major effort to sample ichthyoplankton on a Gulfwide basis. Plankton samples are taken at stations arranged in a systematic grid across the GOM. An annual larval index for the Atlantic bluefin tuna is generated each year from the spring survey and is used by the International Commission for the Conservation of Atlantic Bluefin Tunas to estimate stock size. The objective of the fall survey is to collect ichthyoplankton samples with bongo and neuston gear for the purpose of estimating abundance and defining the distribution of eggs, larvae, and small juveniles of GOM fishes, particularly king and Spanish mackerel, lutjanids and sciaenids.

The accumulating SEAMAP data has not been synthesized on a regular basis. There are some examples of data synthesis for specific areas. Lyczkowski-Shultz et al. (2004) synthesized SEAMAP data between 1982 and 1999 for a localized area in the northeastern GOM (NEGOM) including the Desoto Canyon. Comparison of the NEGOM area with the overall SEAMAP survey area of the entire northern Gulf revealed that the larvae of 16 taxa occurred more frequently and were relatively more abundant in the NEGOM area than the entire SEAMAP survey area, while for other taxa, occurrence and relative abundance were comparable. These taxa represented fishes from mesopelagic, continental shelf, and reef assemblages and the authors concluded that they reflected the wide diversity of habitats available in the NEGOM. Distinct distribution patterns were observed among larvae in the NEGOM study area that appear to be associated with the presence of the DeSoto Canyon as well as proximity to the influence of input from the Mississippi River.

Lyczkowski-Shultz et al. (2000) examined Gulf SEAMAP data from surveys in 1982 to 1995 for only young beryciform fishes, 1 of 42 orders of teleost fishes including the soldierfishes, squirrelfishes, roughies, flashlight fishes, and others. This analysis yielded new insights into the early life history of these unusual, rarely collected fishes. The squirrelfishes and soldierfishes (family Holocentridae) were the most numerous group. Nearly as numerous were the young of the bigscales (family Melamphaidae). Only a few specimens were observed in each of the remaining four families: Polymixiidae, Diretmidae, Trachichthyidae, and Gibberichthyidae.

Some independent ichthyoplankton studies have been conducted, focusing specifically on the influence of offshore platforms. The first comprehensive project was an MMS-funded study by Hernandez et al. (2001) that sampled three platforms as well as a nearshore rock jetty. A follow-on study also supported by MMS by Shaw et al. (2001) looked at several platforms both east and west of the Mississippi River Delta. Both Hernandez et al. (2001) and Shaw et al. (2001) found highest taxonomic richness and diversity at mid-shelf platforms. Larval and juvenile fish assemblages seemed to be influenced by across-shelf gradients of increasing depth. Reef taxa were most abundant and diverse at the mid-shelf platforms, primarily because of the large numbers of larval and juvenile blenniids, pomacentrids, and lutjanids. This high abundance and diversity at mid-shelf could be attributed to the high concentration of platforms (i.e., more potential sources of larvae) and the favorable environmental conditions at mid-shelf (Gallaway, 1981; LGL and SAIC, 1998; Tolan, 2001). The only differences observed by Shaw et al. (2001) in the larval and juvenile fish assemblages across longitudinal gradients (i.e., east or west of the Delta) were differences in the abundance of certain taxa. Higher abundance of these taxa east or west of the Delta may, in turn, reflect differences in the hydrographic conditions and/or habitat availability. Despite the higher concentration of natural reef-type habitats east of the Delta, reef larvae were not more abundant at platforms in these areas.

Previous EIS documents (USDOI, MMS, 2001a and 2002a) detailed ichthyoplankton diversity from some of the larger studies in the 1980's and 1990's. Some studies looked exclusively at the surf zone (Ruple, 1984) and others from specific depth zones or hydrographic features. Richards (1990) estimated that there are 200 families with more than 1,700 species whose early life stages may occur in the GOM. In addition to the resident fauna, many eggs, larvae, and juveniles may be advected into the Gulf from the Caribbean Sea via the Loop Current. Ditty et al. (1988) summarized information from over 80 ichthyoplankton studies from the northern GOM (north of 26º N. latitude) and reported 200 coastal and oceanic fishes from 61 families. CSA (2000) also presents a good summary of all major ichthyoplankton collections throughout the GOM since the late 1950's.

Two of the most important hydrographic features in the GOM are the Mississippi River discharge plume and the Loop Current. In the case of the river plume, hydrodynamic convergence and the continually reforming turbidity fronts associated with the discharge plume probably account for the concentration of larval fishes at the front. Frontal waters in both the river plume and eddy boundaries provide feeding and growth opportunities for larvae. Recent work has focused on hydrographic features that appear to concentrate biomass of a variety of size scales from phytoplankton to megafauna. The combination of input of nutrients into the Gulf from river outflow and mesoscale circulation features enhances productivity, and thus the abundance (see also **Chapter 3.2.3.3**). Biggs and Ressler (2002) describe deepwater "hot spots" of zooplankton, micronekton, and ichthyoplankton when primary production is enhanced by coarse to mesoscale eddies. Lamkin (1997) also showed that larval fish were associated with the Loop Current and periphery regions of companion cyclones and anticyclones, and Wormuth et al. (2000) documented that deepwater cyclones had locally higher standing stocks of zooplankton and micronekton but only in the upper 100 m (328 ft) of the water column.

Fishes

Finfish

The GOM supports a great diversity of fish resources that are affected by variable ecological factors, including salinity, primary productivity, and bottom type. These factors differ widely across the GOM and between the inshore and offshore waters. Characteristic fish resources are associated with the various environments and are not randomly distributed. Major gradients include rainfall and river output, bottom composition, and depth (Hoese and Moore, 1998). High densities of fish resources are associated with particular habitat types. Most finfish resources are linked both directly and indirectly to the vast estuaries that ring the GOM. Estuaries serve as nursery grounds for a large number of marine fishes that live on the inner continental shelves, such as the anchovies, herrings, mojarras, and drums. The fish species diversity declines with increase in estuary salinity (McEachran and Fechhelm, 1998). Finfish are directly estuary dependent when the population relies on low-salinity brackish wetlands for most of their life history, such as during the maturation and development of larvae and juveniles. Even the offshore demersal species are indirectly dependent on the estuaries because they influence the productivity and food availability on the continental shelf (Darnell and Soniat, 1979; Darnell, 1988). The life history of estuary-dependent species involves spawning on the continental shelf; transporting eggs, larvae, or juveniles to the estuarine nursery grounds; growing and maturing in the estuary; and migrating of the young adults back to the shelf for spawning. After spawning, the adult individuals generally remain on the continental shelf. Movement of adult estuary-dependent species is essentially onshore-offshore with no extensive east-west or west-east migration. Approximately 46 percent of the southeastern U.S. wetlands and estuaries important to fish resources are located within the GOM (Mager and Ruebsamen, 1988). Estuary-dependent species of finfish and shellfish dominate the fisheries of the central and north-central Gulf.

Estuary-related species of commercial importance include menhaden, shrimps, oyster, crabs, and sciaenids. Estuary communities are found from east Texas through Louisiana, Mississippi, Alabama, and northwestern Florida. Darnell et al. (1983) and Darnell and Kleypas (1987) found that the density distribution of fish resources in the Gulf was highest nearshore off the central coast. For all seasons, the greatest abundance occurred between Galveston Bay and the Mississippi River. The abundance of fish resources in the far Western and Eastern GOM is patchy. The high-salinity bays of the Western Gulf contain no distinctive species, only a greatly reduced component of the general estuary community found in lower salinities (Darnell et al., 1983).

The degradation of inshore water quality and loss of Gulf wetlands as nursery areas are considered significant threats to fish resources in the GOM (GMFMC, 2004a). Loss of wetland nursery areas in the north-central Gulf is believed to be the result of channelization, river control, and subsidence of wetlands (Turner and Cahoon, 1988). One major theory for the cause of coastal subsidence is the extraction of oil and gas from coastal areas (Morton et al. 2005). The idea that it causes subsidence has also been discounted, primarily because of the extreme depths of oil and gas reserves. Geological fault movement has been recently identified as another factor causing significant subsidence. Gagliano et al. (2003) noted that many coastal lakes and bays were formed by prehistoric fault events and that faulting may be a more important cause of landloss in some areas than fluid removal. Most oil and gas extraction is from much deeper strata. Dokka (2005) stated that their data do not support the current theory (oil and gas extraction) on the origins of subsidence; they demonstrate that tectonic causes dominate in the area he studied. Dokka's theories on how natural tectonic fault movements cause subsidence run counter to studies that have shown oil extraction and soil compaction as main reasons why the land is sinking. The first author of the USGS research (Morton et al., 2005) commented in a recent interview (Burdeau, 2006) that Dokka did not allow for oil and gas extraction to account for subsidence, but Dokka responded that oil was not drilled in or near the Michoud fault, the area studied in his paper. In contrast, loss of wetland nursery areas in the far Western and Eastern Gulf is believed to be the result of urbanization and poor water management practices (USEPA, 1992).

The hurricane impacts on the Gulf Coast in 2005 were expected to cause severe effects on fishery resources. While there was vast devastation of the oyster populations in Louisiana and Mississippi, in contrast, the populations of shrimp and finfishes in offshore areas of the northern Gulf of Mexico were not significantly impacted (Hogarth, 2005). Surveys conducted in late 2005 documented shrimp and bottom fish populations the same or higher than the previous year, 2004. The 2005 storms caused at least a four-fold increase in the loss of wetlands compared with average annual loss. While coastal wetland habitats are critical to most every commercially important marine resource in the northern Gulf, the wetlands loss due to 2005 hurricanes was not reflected in offshore shrimp and finfish populations.

Estuaries and rivers of the GOM export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas. From the shoreline to a depth of about 20 m, the fish fauna is dominated by sea catfishes (Ariidae), lizardfishes (Synodontidae), and sciaenids (drums, seatrout, kingfish and others) (McEachran and Fechhelm, 1998). These fish are very dependent on estuaries as nursery grounds. Gulf menhaden and members of the Sciaenidae family such as croaker, red and black drum, and spotted sea trout are directly dependent on estuaries during various phases of their life history. The occurrence of dense schools, generally by members of fairly uniform size, is an outstanding characteristic that facilitates mass production methods of harvesting menhaden. The seasonal appearance of large schools of menhaden in the inshore Gulf waters from April to November dictates the menhaden fishery (Nelson and Ahrenholz, 1986). Larval menhaden feed on pelagic zooplankton in marine and estuarine waters. Juvenile and adult Gulf menhaden become filter-feeding omnivores that primarily consume phytoplankton, but also ingest zooplankton, detritus, and bacteria. As filter-feeders, menhaden form a link between estuarine and marine food webs and, in turn, are prey for many species of larger fish (Vaughan et al., 1988). An additional excellent source of fisheries information for both fish and invertebrate species in GOM estuaries can be found in Pattillo et al. (1997)

Out to a depth of 40-50 m, on muddy bottoms, the fish fauna is dominated by porgies (Sparidae), batfishes (Ogcocephalidae), sea-robins (Triglidae) sea basses (Serranidae), and left-eyed flounders (Bothidae). These species are also largely dependent on estuaries as nursery grounds. On shelly or hard bottoms in the same depth range (20 to 40 or 50 m), a slightly different species group occurs dominated by snappers (Lutjanidae) and other spiny-rayed fishes with a preference for hard substrate (McEachran and Fechhelm, 1998). Live-bottom areas of low or high vertical relief partition these significant habitat areas from surrounding sand, shell hash, or mud bottom. Two specific types of these live-bottom areas, topographic features and pinnacles off the Mississippi/Alabama coast, are discussed below. A number of important reef fish species share the common life history characteristics of offshore spawning and transport of larvae inshore to settle in estuaries and seagrass meadows where they spend an obligatory nursery phase before recruiting to adult stocks offshore. Among these fishes are both winter and summer spawners, with gag (*Mycteroperca micolepis*) and grey snapper (*Lutjanus griseus*), respectively, being good examples. Gags have become a particularly significant species in the Eastern Gulf where spawning aggregations have been studied over a significant period. Gags spawn in February and March in a defined area west of the Florida Middle Ground, and larvae are transported inshore to settle in seagrass meadows 30-50 days later. Two new reserves have been designated (described in **Chapter 3.3.1**) in this area where bottom-fishing activities have been prohibited. Juveniles remain in the seagrass nursery areas until October or November when they recruit to adult stocks offshore.

Other reef fish species are considered nonestuary dependent such as the red snapper, which remain close to underwater structure for at least their early years. Recent research has shown that oil and gas platforms play a substantial role in providing habitat to red snapper through the first 2-5 years of life (Peabody and Wilson, 2006; Wilson et al., 2003). Red snapper feed along the bottom on fishes and benthic organisms such as crustaceans and mollusks. Peabody and Wilson (2006) clearly demonstrated the diurnal feeding movements of red snapper moving away from platforms at night to feed on surrounding bottom areas and then returning during the day. Juveniles feed on zooplankton, small fish, crustaceans, and mollusks (Bortone and Williams, 1986; USDOC, NOAA, 1986).

The Gulf also has some limited areas of hard substrate on the continental shelf including topographic features or banks offshore Texas and Louisiana and smaller carbonate features often referred to as pinnacles offshore Mississippi and Alabama. There are thousands of these carbonate mounds or pinnacles dotting the outer continental shelf of Mississippi-Alabama that share many characteristics of patch reefs found in shallow tropical areas. The mounds are discrete, vary in size and structural complexity, and are surrounded by level sediment bottoms. The fish community associated with pinnacles is summarized in Snyder (2001). This four-year project investigated pinnacle features ranging in depth between 60 and 90 m. This fish assemblage is much less diverse than the reef fish assemblages reported for water depths less than 50 m, but it is distinctive in its species composition and is characterized by the presence of a core group of deep reef forms including roughtongue bass (*Pronotogrammus martinicensis*), wrasse basslet (*Liopropoma eukrines*), tattler (*Serranus phoebe*), short bigeye (*Pristigenys alta*), yellowtail reef fish (*Chromis enchrysura*), bank butterflyfish (*Chaetodon aya*), red barbier (*Hemanthias vivanus*), and scorpionfishes (*Scorpaena* spp). Additional information on this habitat also appears in **Chapter 3.2.2.1.2**.

Topographic features on the mid to outer continental shelf include a wide range of habitat types and fish communities. The most diverse are located at the shelf edge where water quality and temperature allow for the development of coral reef assemblages. The two most spectacular examples are the East and West Flower Garden Banks, thriving coral reefs that come to within 18 m (59 ft) of the sea surface from a surrounding bottom of 100-130 m (328-427 ft) depth. These banks are more fully described in **Chapter 3.2.2.1.2**. The fish assemblage at the Flower Garden Banks has been documented in several studies; the most comprehensive is in Boland et al. (1983) extending from the reef crest to soft-bottom habitat resulting in a total of 357 hours of survey video. Analysis of that data resulted in a total of 141 separate fish taxa, in some cases not identified to the species level from visual evidence alone. This study separated habitat types into eight categories and determined fish abundance for each. The reef crest was dominated by the creolefish (*Paranthias furcifer*) with densities as high as 210 per 1,000 m². Total standing stock determinations were also made for 16 reef fish taxa in Boland et al. (1983). Other abundant species on the East and West Flower Garden Banks (FGB's) coral caps include creole wrasse, blue and brown chromis, several species of parrot fish, and several damselfish species. An early account of the fish assemblage at the Flower Garden Banks appears in Bright and Cashman (1974) where a total of 101 fish species were reported. In more recent surveys performed by divers, a total of 117 fish species were seen by the survey teams at both the East and West Flower Garden Banks (Pattengill-Semmens et al., 2000).

The remaining OCS, ranging to a depth of approximately 200 m (656 ft), generally has a muddy or silty soft bottom. Fishes dominating this habitat include hakes (Phycidae), scorpionfishes (Scorpaenidae), and ogcocephalids (batfishes) (McEachran and Fechhelm, 1998). In this region where hard bottom occurs, some of the reef fish species that occur on the upper shelf can also be found. In addition, some species are particularly adapted for deeper hard-bottom areas including snowy grouper, warsaw grouper, yellowedge grouper, and gag. In the case of the warsaw and snowy grouper, their habitat has been documented to extend onto the upper continental slope to depths of 500 m (1,640 ft) on occasion (FishBase, 2006a).

Deepwater demersal fishes below several hundred meters of depth are better known than the deep pelagic species. Three major deep-sea studies have collected demersal fish throughout the depth range of the Gulf's continental slope between the 1960's and as recently as 2003. The first comprehensive look at the deeper part of the Gulf was by a long series of cruises by Pequegnat between 1964 and 1973 (Pequegnat, 1983). Pequegnat reported a total of 206 demersal fish species within 47 families. The Macrouridae (rattails) was the most speciose family represented by 30 species, followed by Ophidiidae (cusk-eels) with 23 species. Gallaway et al. (1988) trawled 60 continental slope stations ranging in depth from 278 to nearly 3,000 m (9,842 ft), collecting a total of 5,400 fishes and 126 species. Only five species were represented by more than 300 specimens; the Atlantic batfish (*Dibranchus atlanticus*) was the most common. The other four most abundant included a hake (*Urophycis cirratus*), the flathead (*Bembrops gobiodes*), the cutthroat eel (*Synaphobranchus oregoni*), and the rattail (*Chlorophthalmus agassizi*). These same stations were also photographed by a still camera system, the two techniques showing significant differences indicating an undersampling by standard trawling techniques. Densities of fish determined from photography exceeded that estimated from trawling at all but one station by as much as one or two orders of magnitude. The mean density of fish determined from photography was

198.5 per hectare (1 ha = 10,000 m²). Most recently, a second large MMS-funded deepwater study was recently completed in 2006. Rowe and Kennicutt (in prepartion) also sampled a wide range of depths throughout the northern GOM and also several stations in Mexican waters. Trawling for demersal fishes was conducted during 2000, 2001, and 2003 surveys of the study; however, the only comprehensive survey occurred in the 2000 survey. During the 2000 survey, fishes were captured at 31 of the 43 stations representing all of the Deep Gulf of Mexico Benthos (DGoMB) transects ranging in depths from 188 to 3,075 m (617 to 10,089 ft). A total of 1,065 individual demersal fishes, representing 119 species and 42 families, were collected in the 31 trawl collections. The families Macrouridae (grenadiers or rattails), with 21 species; Ophidiidae (cuskeels), with 15 species; and Alepocephalidae (slickheads), with eight species, dominated the samples. Cluster analyses resulted in four major assemblages. These consisted of an OCS assemblage between 188 and 216 m (617 and 709 ft), an upper slope assemblage between 315 and 785 m, a mid-slope assemblage between 686 and 1,369 m (2,251 and 4,491 ft), and a deep assemblage between 1,533 and 3,075 m (5,030 and 10,089 ft).

Recruitment is by far the most important, yet the least understood, factor contributing to changes in the numbers of harvestable Gulf fish. Natural phenomena such as weather, hypoxia, and red tides may reduce standing populations. Studies of abundance, growth and mortality that affect recruitment have demonstrated the difficulty in making estimates over time or comparing different areas. As an example, Scharf (2000) examined red drum data from nine estuaries along the Texas Gulf Coast during a 20-year period and determined that estimates of abundance and mortality exhibited order-of-magnitude differences. Variations were also not related among estuaries, suggesting that factors affecting the survival of young red drum were specific to individual estuarine systems.

Recently, hurricanes have been a prominent impacting factor to Gulf resources and have affected fish resources by destroying oyster reefs and changing physical characteristics of inshore and offshore ecosystems. The intense storm season of 2005, including Hurricanes Katrina and Rita, did not affect the offshore fisheries as much as initially expected. It was initially believed that the 2005 hurricanes would have devastating effects on the health and numbers of offshore fish stocks in the GOM. Research results from NOAA Fisheries Service have indicated that these expectations did not occur (USDOC, NOAA Fisheries Service, 2005a). The NOAA's annual survey of shrimp and bottomfish (completed in November 2005) shows some species, such as the commercially valuable and overfished red snapper, had a higher population in 2005 than in 2004. The survey also found that the Atlantic croaker population doubled in 2005. Studies conducted in Barataria Bay, Louisiana, post-Katrina/Rita also indicated shrimp and fish abundance at near normal levels and water temperatures and salinities near normal. Thus, it appears that shrimp and finfish resources of the northern Gulf fared much better during and after the hurricanes than did the fishing infrastructure that uses them (Hogarth, 2005).

Pelagics

Pelagic fishes occur throughout the water column from the beach to the open ocean. Water-column structure (temperature, salinity, and turbidity) is the only partitioning of this vast habitat. On a broad scale, pelagic fishes recognize different watermasses based upon physical and biological characteristics. Some sources divide pelagic waters into three subdivisions by depth: the epipelagic from the surface to a depth of 200 m (656 ft), the mesopelagic from 200 to 1,000 m (656-3,281 ft), and the bathypelagic below 1,000 m (3,281 ft). The epipelagic is then divided into the coastal and oceanic, the first overlying the continental shelf and the oceanic representing the area seaward of the shelf (McEachran and Fechhelm 1998). Four ecological groups will be presented individually here, delineated by watermass:

- coastal pelagic species;
- oceanic pelagic species;
- mesopelagic species; and
- bathypelagic species.

For coastal pelagic fishes, commercial fishery landings are one of the best sources of information because these species are an important component of nearshore net and hook-and-line fisheries. Some smaller nektonic fishes occupying the surf zone along exposed beaches have been collected with seines (Naughton and Saloman, 1978; Ross, 1983). Information on the distribution and abundance of oceanic species comes from commercial longline catches and recreational fishing surveys. In addition, NOAA Fisheries Service has conducted routine surveys of the GOM billfishery since 1970 (Pristas et al., 1992). Mesopelagic species are not harvested commercially but have been collected in special, discrete-depth nets that provide some quantitative data on relative abundance (Bakus et al., 1977; Hopkins and Lancraft, 1984; Gartner et al., 1987; Sutton and Hopkins, 1996).

Coastal Pelagics (Epipelagic)

Coastal pelagic species traverse shelf waters of the region throughout the year. The major coastal pelagic families occurring in the region are Carcarhinidae (requiem sharks), Elopidae (ladyfish), Engraulidae (anchovies), Clupeidae (herrings), Scombridae (mackerels and tunas), Carangidae (jacks and scads), Mugilidae (mullets), Pomatomidae (bluefish), and Rachycentridae (cobia). The distribution of most species depends upon water-column structure, which varies spatially and seasonally. Some coastal pelagic species show an affinity for vertical structure and are often observed around natural or artificial structures, where they are best classified as transients rather than true residents. Some species form large schools (e.g., Spanish mackerel), while others travel singly or in smaller groups (e.g., cobia). King mackerel in the GOM exist in two populations, an eastern group and a western group. The eastern population migrates from near the Mississippi Delta eastward, then southward around the Florida Peninsula, wintering off southeastern Florida (Sutter et al., 1991). The western population travels to waters off the Yucatan Peninsula during winter. In summer, both populations migrate to the northern GOM, where they intermix to an unknown extent. Spanish mackerel, cobia, bluefish, jack crevalle, and coastal sharks are migratory, but their routes have not been studied.

Coastal pelagic fishes can be divided into two ecological groups. The first group includes large predatory species such as king and Spanish mackerels, bluefish (*Pomatomus saxatilis*), cobia, jacks (*Caranx* spp.), and little tunny (*Euthynnus alletteratus*). These species typically form schools, undergo migrations, grow rapidly, mature early, and exhibit high fecundity. Each of these species is important to some extent to regional fisheries. The second coastal pelagic ecological group exhibits similar life history characteristics, but the species are smaller in body size and planktivorous. This group is composed of anchovies (*Anchoa* spp.), Gulf menhaden (*Brevoortia patronus*), round scad, Spanish sardine, striped mullet (*Mugil cephalus*), and thread herring (*Opisthonema oglinum*). Species in the second group are preyed upon by the larger species in the first group; thus, the two are ecologically important in energy transfer in the nearshore environment.

Some coastal pelagic species are found along high-energy sandy beaches from the shoreline to the swash zone (Ross, 1983). An estimated 44-76 species, many of them coastal pelagics, occur in the surf zone assemblage. Larger predatory species (particularly bluefish, Spanish mackerel, and blue runner) may be attracted to large concentrations of anchovies, herrings, and silversides that congregate in the surf zone.

Commercial purse seine fisheries generate high landings of several coastal pelagic species in the region. The Gulf menhaden fishery produces the highest fishery landings in the U.S. (USDOC, NOAA Fisheries Service, 2006a). Menhaden form large, surface-feeding schools in waters near the Mississippi Delta from April through September. Fishermen take advantage of this schooling behavior capturing millions of pounds each year with large purse nets (total for 2004 Gulfwide was 1,023,259,717 lb). Other coastal pelagic species contributing high commercial landings are Atlantic thread herring, Spanish sardine, and ladyfish. Most of the large-bodied, predatory coastal pelagic species are important to commercial or recreational fisheries. King and Spanish mackerel, cobia, and jacks are sought by the charter and head-boat fisheries in the region.

Oceanic Pelagics (Epipelagic)

Common oceanic pelagic species include tunas, marlins, sailfish, swordfish, dolphins, wahoo, and mako sharks. In addition to these large predatory species, there are halfbeaks, flyingfishes, and driftfishes (Stromateidae). Lesser-known oceanic pelagics include opah, snake mackerels (Gempylidae), ribbonfishes (Trachipteridae), and escolar. The lower section of this epipelagic/oceanic pelagic zone has a distinct fauna, consisting of the poorly known oarfishes and relatives in addition to fishes with great depth ranges such as Scombridae (tunas) and Xiphiidae (swordfishes) (McEachran and Fechhelm, 1998).

Oceanic pelagic species occur throughout the GOM, especially at or beyond the shelf edge. Oceanic pelagics are reportedly associated with mesoscale hydrographic features such as fronts, eddies, and discontinuities. Many of the oceanic fishes also associate with drifting *Sargassum*, which provides forage areas and/or nursery refugia. Fishermen contend that yellowfin tuna aggregate near sea-surface temperature boundaries or frontal zones; however, Power and May (1991) found no correlation between longline catches of yellowfin tuna and sea-surface temperature (defined from satellite imagery) in the GOM. Other sorts of frontal zones such as “tide lines” are well known for attraction of some species such as dolphin (*Coryphaena hippurus*). Offshore platforms in deepwater have recently been identified as significant attraction devices for tuna, especially yellowfin (Edwards et al. 2002). There are a total of 39 structures currently operating in the GOM in water depths of 1,000 ft or greater. The occurrence of bluefin tuna larvae in the GOM associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that these species spawn in the GOM (Richards et al., 1989). Block et al (2001) also reported on the GOM being used as a breeding ground and demonstrated trans-Atlantic migrations of bluefin tuna between the eastern Mediterranean, Atlantic and GOM using electronic data storage tags.

Mesopelagics

The mesopelagic realm is below the photic zone and below the permanent thermocline. Mesopelagic fish assemblages in the GOM are numerically dominated by myctophids (lanternfishes), with gonostomatids (bristlemouths) and sternoptychids (hachetfishes) common but less abundant in collections. These fishes make extensive vertical migrations during the night from mesopelagic depths (200-1,000 m) to feed in higher, food rich layers of the water column (McEachran and Fechhelm, 1998). Mesopelagic fishes are important ecologically because they transfer substantial amounts of energy between mesopelagic and epipelagic zones over each diel cycle.

Sutton and Hopkins (1996) investigated the trophic ecology of the stomiid assemblage (Stomiidae; dragonfishes and viperfishes) in the Eastern GOM. Over 1,400 specimens representing 69 species and 17 genera were examined. Four patterns of feeding were evident among the abundant stomiids: (1) myctophid predation; (2) zooplankton/small micronekton predation; (3) penaeidean shrimp predation; and (4) copepod/micronekton predation. Lanternfishes were found to feed mostly on crustacean zooplankton (copepods) (Hopkins and Gartner, 1992; Hopkins et al., 1997).

Lanternfishes were most common in the catches made by Bakus et al. (1977) and Hopkins and Lancraft (1984). Gartner et al. (1987) collected 17 genera and 49 species of lanternfish in trawls fished at discrete depths from stations in the south, Central, and Eastern Gulf. Lanternfishes generally spawn year-round, with peak activity in spring and summer (Gartner, 1993). The most abundant species in decreasing order of importance were *Ceratoscopleus warmingii*, *Notolychus valdiviae*, *Lepidophanes guentheri*, *Lampanyctus alatus*, *Diaphus dumerili*, *Benthosema suborbitale*, and *Myctophum affine*.

Bathypelagics

The deeper dwelling bathypelagic fishes inhabit the water column at depths greater than 1,000 m (3,281 ft) and seldom migrate into shallower waters. This zone receives no sunlight and temperatures range from 4°C to 10°C. Deep-sea angler fishes (Ceratioidei) dominate this realm in most seas, but they are poorly known from the GOM (McEachran and Fechhelm, 1998). Numerous species of gonostomatids (bristlemouths or lightfishes) and scaleless black dragonfishes (Melanostomiidae) are found in the bathypelagic of the Gulf. There are 4 orders, 13 families, and 49 species known for the GOM. Like mesopelagic fishes, most species are capable of producing and emitting light (bioluminescence) to aid in communication in an environment devoid of sunlight (Snyder, 2000).

Invertebrates (“Shellfish” and Corals)

A number of invertebrate groups are considered “fisheries,” including shrimp, crabs, oysters, and even corals. While none of these groups are fish resources, they will be briefly mentioned here as well as in the following section dealing with essential fish habitat and fishery management plans.

To a great degree, estuaries determine the shellfish resources of the GOM. Life history strategies are influenced by tides, lunar cycles, maturation state, and estuarine temperature changes. Very few individuals live more than a year, and most are less than six months old when they enter the extensive inshore and nearshore fishery. Year-to-year variations in shellfish populations are frequently as high as 100 percent and are most often a result of extremes in salinity and temperature during the period of larval development. Shellfish resources in the Gulf range from those located only in brackish wetlands to those found mainly in saline marsh and inshore coastal areas. Life history strategies reflect estuary relationships, ranging from total dependence on primary productivity to opportunistic dependence on benthic organisms.

Up to 15 species of penaeid shrimp can be expected to use the coastal and estuarine areas in the GOM. Brown, white, and pink shrimp are the most numerous. Pink shrimp have an almost continuous distribution throughout the Gulf but are most numerous on the shell, coral sand, and coral silt bottoms off southern Florida. Brown and white shrimp occur in both marine and estuarine habitats. Adult shrimp spawn offshore in high salinity waters; the fertilized eggs become free-swimming larvae. After several molts they enter estuarine waters as postlarvae. Wetlands within the estuary offer both a concentrated food source and a refuge from predators. After growing into juveniles, the shrimp larvae leave the saline marsh to move offshore where they become adults. The timing of immigration and emigration, spatial use of a food-rich habitat, and physiological and evolutionary adaptations to tides, temperature, and salinity differ between the three species. Royal red shrimp are also included in NOAA's shrimp fishery management and occur in the deep GOM. They live at water depths between 180 m (591 ft) and 730 m (2,395 ft) (GMFMC, 2004a). The depth range where they can occur in any abundance is even narrower, between 250 m (820 ft) and 475 m (1,558 ft). Spawning is believed to occur from winter to spring (GMFMC, 2004a). In the Gulf, commercial concentrations have been reported from two different bottom types: blue-black terrigenous silt and silty sand off the Mississippi River Delta, and whitish, calcareous mud off the Dry Tortugas (GMFMC, 1996). Additional distribution and food habit information is available in GMFMC (2004a).

The severe storm season of 2005 severely impacted estuary habitat of Louisiana, Mississippi, and Alabama. Total wetlands loss has been conservatively estimated to be over 100 mi^2 in eastern Louisiana alone due to these storms (Hogarth, 2005). By far, the worst resource devastation has occurred for oyster populations. According to Mississippi Department of Marine Resources estimates, approximately 90 percent of Mississippi's oyster beds were damaged and disrupted by Hurricane Katrina (Hogarth, 2005). Through early 2006, 100 percent of Mississippi's oyster fleet is out of work because of Hurricane Katrina. Oyster populations were similarly affected in parts of Louisiana. It was expected that the Gulf Coast shrimp population would have been severely impacted by the 2005 hurricanes, but the annual NOAA shrimp and bottomfish survey in the fall of 2005 indicated that shrimp abundance was the same or slightly higher than in the fall of 2004 and was widely distributed.

About eight species of portunid (swimming) crabs use the coastal and estuarine areas in the GOM. Blue crab (*Callinectes sapidus*) is the only species that is located throughout the Gulf and comprises a substantial fishery. They occur on a variety of bottom types in fresh, estuarine, and shallow offshore waters. Spawning grounds are areas of high salinity such as saline marshes and nearshore waters.

Vast intertidal reefs constructed by sedentary oysters are prominent biologically and physically in estuaries of the GOM. Finfishes, crabs, and shrimp are among the animals using the intertidal oyster reefs for refuge and also as a source of food, foraging on the many reef-dwelling species. Oyster reefs, as they become established, modify tidal currents and this, in turn, affects sedimentation patterns. Further, the reefs contribute to the stability of bordering marsh (Kilgen and Dugas, 1989). Additional information on all of the above shrimp and other invertebrate fisheries and their life histories can be found in GMFMC (2004a).

Corals of all varieties are also managed as a "fishery" with a fishery management plan included in the discussion in the next section. Details of coral distribution is not included here and can be found in **Chapter 3.2.2.1** (Continental Shelf Benthic Resources) for shallow shelf waters and reef-building coral species, and **Chapter 3.2.2.2.2** (Nonchemosynthetic Communities) for deepwater corals.

3.2.8.2. Essential Fish Habitat

The Essential Fish Habitat Program in the Gulf of Mexico

As outlined in **Chapter 1.3**, the Magnuson Fishery Conservation and Management Act of 1976, as amended through 1998 and 2005, places requirements on any Federal agency regarding essential fish habitat (EFH). The MMS must describe how actions under their jurisdiction may affect EFH. All Federal agencies are encouraged to include EFH information and assessments within NEPA documents.

Essential Fish Habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described above), EFH for the GOM previously included all estuarine and marine waters and substrates from the shoreline to the seaward limit of the U.S. Exclusive Economic Zone (EEZ). Although technically valid, this approach, for one example, failed to make any distinction between the vast deepwater areas of the northern GOM as compared to very different coastal and other more limited and important habitat areas of the continental shelf. Through extensive analysis in GMFMC (2004a), a new approach was adopted with Generic Amendment 3 to all GOM Fishery Management Plans. New EFH designated areas are now specific for each managed species. The Proposed Action in the Generic Amendment (GMFMC, 2005) will reduce the extent of EFH relative to the 1998 Generic Amendment by removing EFH description and identification from waters between 100 fathoms (183 m, 600 ft) and the seaward limit of the EEZ (as deep as 3,200 m (10,499 ft). However, the habitats most important to managed species (i.e. those shallower than 100 fathoms (183 m, 600 ft)) will still be designated as EFH, and so the great majority of benefits to the biological environment will remain. The new Amendment also maintains the trigger for consultation and/or conservation recommendations for any Federal agency that proposes actions that may adversely affect EFH required under Sections 305(b)(2)-(4) of the Magnuson-Stevens Act.

The EFH regulations also recommend that Fishery Management Plans identify habitat areas of particular concern (HAPC's) within areas identified as EFH. The HAPC designation does not confer additional protection or restrictions upon an area, but can help prioritize conservation efforts. The general types of HAPC include the following: nearshore areas of intertidal and estuarine habitats that may provide food and rearing for juvenile fish and shell fish managed by the Fishery Management Council (FMC); offshore areas with substrates of high habitat value or vertical relief, which serve as cover for fish and shell fish; and marine and estuary habitat used for migration, spawning, and rearing of fish and shellfish. Marine sanctuaries and national estuary reserves have been designated in the area managed by the GMFMC and are considered to be HAPC's that meet the above general guidelines.

In the original 1998 GMFMC Amendment, the HAPC's located within the area of the Gulf considered in this EIS were limited to the Flower Garden Banks National Marine Sanctuary, Weeks Bay National Estuarine Research Reserve, and Grand Bay, Mississippi. Other areas designated HAPC by GMFMC (1998) included the Florida Middle Grounds, Apalachicola National Estuarine Research Reserve (southeast of Panama City, Florida), Rookery Bay National Estuarine Research Reserve(south of Naples, Florida), the Florida Keys National Marine Sanctuary, and the Dry Tortugas. Amendment 3 finalized in 2005 (GMFMC, 2005), proposed additional HAPC's including the Madison-Swanson Marine Reserves, Tortugas North and South Ecological Reserves, Pulley Ridge, and several individual reefs and banks of the northwestern GOM in addition to the East and West Flower Garden Banks and Stetson Bank that comprise the FGB Sanctuary. These additional banks are Sonnier Bank, MacNeil, 29 Fathom Bank, Rankin Bank, and Bright Bank (two Rankin Banks and Bright Bank were combined as a single entity although they are three separate features with some minor topography between them), Geyer Bank, McGrail Bank, Bouma Bank, Rezak-Sidner Banks, Alderdice Bank, and Jakkula Bank. The GMFMC Amendment lists these additional areas as a preferred alternative for new HAPC's.

The eight newly proposed banks were mischaracterized as topographic features that rise to within 60 ft of the water surface in the GMFMC (2004a) EIS. Of the eight banks, only Sonnier reaches a 18 m (60 ft) depth, the next shallowest is Bright and Geyer Banks at a depth of about 115 ft (35 m). The shallowest area of McGrail Bank reaches a depth of about 45 m (150 ft). All of the other banks have crests deeper than McGrail. McGrail Bank does have a significant area of hermatypic coral cover (up to 30% cover) on its peak between 45 and 60 m (148 and 197 ft) (Hickerson and Schmahl, 2005). McGrail Bank was also the only bank of the eight new HAPC sites added to those areas considered coral "reefs" including proposed measures to protect it from the adverse effects of fishing (there are many definitions of "coral reef," most of which do not fit the McGrail Bank situation, i.e., the presence of reef-building coral does not define a coral reef by itself). New proposed protective measures for coral HAPC (GMFMC, 2005) included prohibition of bottom anchoring and use of trawling or other bottom contact fishing gear. It should be noted the boundary of the McGrail Bank HAPC as well as all the other recent banks identified as HAPC in GMFMC (2005) have boundaries much larger than the sensitive biological habitat intended to be identified as HAPC to allow for the convenience of drawing simple rectangular boundaries, e.g., nearly half of the Rankin/Bright HAPC is soft mud bottom deeper than 120 m (394 ft) (GMFMC, 2005; Figure 12a).

EFH Assessment

As a Federal agency proposing future activities that may impact EFH, an EFH Assessment is required. The requirements for an EFH description and assessment are as follows: (1) description of the proposed action; (2) description of the action agency's approach to protection of EFH and proposed mitigation, if applicable; (3) description of EFH and managed and associated species in the vicinity of the proposed action; and (4) analysis of the effects of the proposed and cumulative actions on EFH, the managed species, and associated species. **Chapters 1 and 2** contain descriptions of the proposed actions. **Chapters 1.3 and 2.2.2** discuss MMS's approach to the preservation of EFH with specific mitigations. **Chapter 3.2.1** details coastal areas that are considered EFH including wetlands and areas of submerged vegetation. **Chapter 3.2.2.1.1** describes live-bottom formations and their biotic assemblages, which are considered EFH. Below is a discussion of managed species and additional mitigating factors. **Chapters 4.2.1.1.8 and 4.2.2.1.10** contain the impact analysis of the proposed actions on EFH. **Chapter 4.4.10** contains the impact analysis for accidental spills on EFH. **Chapter 4.5.10** contains the impact analysis of cumulative actions.

Managed Species

In the first Generic Amendment (GMFMC, 1998), the GOM Fishery Management Council described EFH for the following species. These species or species complexes are brown shrimp (*Penaeus aztecus)*, pink shrimp (*Penaeus duorarum)*, white shrimp (*Penaeus setiferus*), royal red shrimp (*Pleoticus robustus*), red drum (*Sciaenops ocellata*), black grouper (*Mycteroperca bonaci*), red grouper (*Epinephelus morio*), gag (*Mycteroperca microlepis*), scamp (*Mycteroperca phenax*), red snapper *(Lutjanus campechanus*), gray snapper (*Lutjanus griseus*), yellowtail snapper (*Ocyurus chrysurus*), lane snapper (*Lujanus syngagris*), vermilion snapper (*Rhomboplites aurorubens*), gray triggerfish (*Balistes capriscus*), greater amberjack (*Seriola dumerili*), lesser amberjack (*Seriola fasciata*), tilefish (Branchiostegidae), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum*), dolphin (*Coryphaena hippurus*), little tunny (*Euthynnus alleteratus*), stone crab (*Menippe spp*.), spiny lobster (*Panulirus spp*.), and coral (Anthozoa). The current number of fish species included in Fishery Management Plans (FMP's) is a larger total of 54. All of these species are listed in **Table 3-9**. The additional numbers come primarily from additional snapper, grouper and tilefish species in the Reef Fish FMP (43 total). Many of these managed species do not occur or very rarely occur in the lease sale areas considered in this EIS. None of the fish stocks managed by the GMFMC are endangered or threatened, although two *Acropora* coral species were listed as threatened in 2006 (USDOC, NOAA, 2006b). There are only two known living coral colonies of *Acropora* in the entire northern Gulf of Mexico: one on the East Flower Garden Bank and one on the West Flower Garden Bank. One grouper species, the Nassau, is "protected" in that it is listed as a species of concern and harvest is prohibited. The goliath grouper was removed from the species of concern list in March 2005.

Occurrence of the initially identified managed species, along with major adult prey species and relationships with estuary and bay systems in the northern GOM is outlined in **Table 3-10**. Detailed presentations of species abundance, life histories, and habitat associations for all life history stages are presented in the Generic Amendment for Essential Fish Habitat by the GMFMC (1998). However, a great deal of new information has appeared since the publication of the first 1998 Amendment. The recent EIS prepared prior to the new Amendment 3 (GMFMC, 2005) contains substantial new information for all 54 managed species listed in **Table 3-9.** Details include extensive tables on depth preferences, habitat use by life history stage, and summaries of occurrence by eco-region (five regions covering the entire northern Gulf Coast). These tables are too extensive to repeat here and are referenced (GMFMC, 2004; pages 8-14 to 8-91).

The Central and Western Gulf was reviewed for the occurrence of EFH for the species above. Essentially all of these species were determined to have at least one life history stage occurring in or near the area. The GMFMC (2004) did not indicate EFH for spiny lobster (*Panulirus spp.*) or yellowtail snapper (*Ocyurus chrysurus*) in the sale areas, but both species are known to occur on topographic features such as the Flower Garden Banks and Sonnier Bank in the CPA.

Tuna (Scombridae), billfish (Istiophoridae), swordfish (Xiphiidae), and sharks (Squaliformes) are under the direct management of NOAA Fisheries Service and are not included as Fishery Management Council managed species. The EFH areas for these highly migratory species (HMS) are described in separate FMP's, including the FMP for Atlantic tunas, swordfish, and sharks (USDOC, NOAA Fisheries Service, 1999a) and the Atlantic billfish FMP Amendment 1 (USDOC, NOAA Fisheries Service, 1999b). These separately managed species include albacore tuna (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), bluefin tuna (*Thunnus thynnus*), skipjack tuna (*Euthynnus pelamis*), yellowfin tuna (*Thunnus albacares*), swordfish (*Xiphias gladius*), a suite of 32 shark species (Squaliformes), and billfish (Istiophoridae) species including the blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), sailfish *Istiophorus platypterus*), and longbill spearfish (*Tetrapturus pfluegeri*).

As described by NOAA Fisheries Service documents (USDOC, NOAA Fisheries Service, 1999a and b), the current status of the scientific knowledge of these species is such that habitat preferences are largely unknown or are difficult to determine. Some new information is emerging, such as the remarkable transoceanic migrations of bluefin tuna as described by Block et al. (2001) and others. Several tuna species, particularly the yellowfin, appear to exhibit strong attraction behavior to offshore deepwater oil and gas structures (Edwards and Sulak, 2003; Edwards et al., 2002). As in the case with shark species, it is difficult to define the habitat of sharks of this temperate zone in the GOM because most species are highly migratory, using diverse habitats in apparently nonspecific or poorly understood ways. Temperature is a primary factor affecting the distribution of sharks, and their movement in coastal waters is usually correlated with unpredictable seasonal changes in water temperature.

Similar to the species managed by the GMFMC described above, the occurrence of these 14 species managed by NOAA Fisheries Service, along with major prey species, is outlined in **Table 3-11**. Bay and estuary relationships are not cited in the FMP's except in one instance of the bull shark where estuary areas are used as a nursery area. As additional life history information is developed, additional use of inshore and estuary area may be included as EFH in the future.

Most, if not all 14 highly migratory species occur beyond the 100-fathom (600 ft, 183-m) water depth contour now identified as GOM EFH for GMFMC managed species. Many of these highly migratory species such as billfishes are associated with upwelling areas where canyons cause changes in current flow (upwelling) and create areas of higher productivity.

Addressing Essential Fish Habitat Requirements

The GMFMC's *Generic Amendment for Addressing Essential Fish Habitat Requirements* (GMFMC, 1998) identifies threats to EFH and makes a number of general and specific habitat preservation recommendations for pipelines and oil and gas exploration and production activities within State waters and OCS areas.

The general recommendations for State waters and wetlands are as follows:

(1) Exploration and production activities should be located away from environmentally sensitive areas such as oyster reefs, wetlands, seagrass beds, endangered species habitats, and other productive shallow water areas. Use of air boats instead of marsh buggies should be implemented whenever possible.

(2) Upon cessation of drilling or production, all exploration/production sites, access roads, pits and facilities should be removed, backfilled, plugged, detoxified, revegetated and otherwise restored to their original condition.

(3) A plan should be in place to avoid the release of hydrocarbons, hydrocarbon-containing substances, drilling muds, or any other potentially toxic substance into the aquatic environment and the surrounding area. Storage of these materials should be in enclosed tanks whenever feasible or, if not, in lined mud pits or other approved sites. Equipment should be maintained to prevent leakage. Catchment basins for collecting and storing surface runoff should be included in the project design.

Individual States, the COE, and USEPA have review and permit authority over oil and gas development and production within State waters. All oil and gas activities in coastal or wetland areas must adhere to numerous conservation measures before receiving permits from these agencies. In order to minimize potential coastal impacts from OCS-related activities, MMS has numerous safety, inspection, and spill response requirements in place to prevent an accidental release of hydrocarbons from either happening at all or from reaching land (**Chapters 1.5, 4.3.1, and 4.3.2**).

The *Generic Amendment* (GMFMC, 1998) lists a number of measures that may be recommended in association with exploration and the production activities located close to hard banks and banks containing reef-building coral on the continental shelf. These recommendations are as follows:

(1) Drill cuttings should be shunted through a conduit and discharged near the seafloor, or transported ashore, or to less sensitive, NOAA Fisheries Service-approved offshore locations.

(2) Drilling and production structures, including pipelines, generally should not be located within one mile of the base of a live reef.

(3) All pipelines placed in waters less than 300 ft deep should be buried to a minimum of 3 ft beneath the seafloor, where possible. Pipeline alignments should be located along routes that minimize damage to marine and estuarine habitat. Buried pipelines should be examined periodically for maintenance of adequate earthen cover.

(4) In anchorage areas, all abandoned structures must be cut off 25 ft below the mud line. If explosives are to be used, NOAA Fisheries Service should be contacted to coordinate marine mammal and endangered species concerns.

(5) All natural reefs and banks, as well as artificial reef areas, should be avoided.

The 1998 *Generic Amendment* makes an additional specific recommendation regarding OCS oil and gas activities under review and permit authority by MMS and USEPA. Specifically, for the conservation of EFH, activities should be conducted so that petroleum-based substances such as drilling mud, oil residues, produced waters, or other toxic substances are not released into the water or onto the seafloor.

The most recent Generic Amendment 3 (GMFMC, 2005) also included comments regarding oil and gas exploration and production activities on the continental shelf. Item Nos. 1, 2, and 5 above were the same as in the previous 1998 Amendment. Item No. 3 was altered to read “waters less than 200 ft” for burial of pipelines as opposed to 300 ft before and also adding “Where this is not possible and in deeper waters where user-conflicts are likely, pipelines should be marked by lighted buoys and/or lighted ranges on platforms to reduce the risk of damage to fishing gear and the pipelines.” Also, Item No. 5 above was altered in 2005 to read “15 ft below the mud line” for structure removal as opposed to 25 ft indicated before. The changes to these two items now reflect the actual policy MMS has historically followed.

The MMS lease sale stipulations and regulations already incorporated many of the suggested EFH conservation recommendations. Lease sale stipulations are considered to be a normal part of the OCS operating regime in the GOM. Compliance with stipulations from lease sales is not optional; application of a stipulation(s) is a condition of the lease sale. In addition, MMS may attach mitigating measures to an application (exploration, drilling, development, production, pipeline, etc.) and issue a Notice to Lessees and Operators (NTL).

The MMS Topographic Features and Live Bottom (Pinnacle Trend) Stipulations were formulated nearly 30 years ago and were based on consultation with various Federal agencies and comments solicited from State, industry, environmental organizations, and academic representatives. These stipulations address conservation and protection of essential fish habitat/live-bottoms areas. The stipulations include exclusion of all oil and gas activity (structures, drilling, pipelines, production, etc.) on or near live-bottom areas (both high-relief and low-relief), mandatory shunting of drilling muds and cuttings near high-relief features, relocation of operations including pipelines away from essential fish habitat/live bottoms, and possible monitoring to assess the impact of the activity on the live bottoms. A continuous annual monitoring study has been ongoing at the East and West FGB since 1988.

Mitigating measures that are a standard part of the MMS OCS Program limit the size of explosive charges used for platform removal, require placing explosive charges at least 15 ft below the mudline, establish No Activity and Modified Activity Zones around high-relief live bottoms, and require remote-sensing surveys to detect and avoid biologically sensitive areas such as low-relief live bottoms, pinnacles, and chemosynthetic communities.

Since the publication of the last multisale EIS for the CPA and WPA (USDOI, MMS, 2002a), a new NTL has been produced—NTL 2004-G05, *Biologically Sensitive Areas of the Gulf of Mexico.* This new NTL combines the former topographic features stipulation guidelines, the live-bottom (pinnacle trend) stipulation, and the live-bottom (low-relief) stipulation. It also created a new class of features not previously identified in stipulations or NTL's—the Potentially Sensitive Biological Feature. This is defined as *not previously identified features of moderate to high relief that provide surface area for the growth of sessile invertebrates and attract large numbers of fish*. This was an important new designation because these kinds of habitats are common outside named topographic features with their associated No Activity Zones and also outside of the 70 live-bottom (pinnacle trend) stipulated blocks. These kinds of habitats also played a major role in determining the boundaries of newly proposed HAPC's.

In consideration of existing mitigation measures, lease stipulations, and a submitted EFH Assessment document, MMS entered into a Programmatic Consultation agreement with NOAA Fisheries Service on July 1, 1999, for petroleum development activities in the WPA and CPA. The NOAA Fisheries Service considered an EFH Assessment describing OCS development activities, an analysis of the potential effects, MMS's views on those effects, and proposed mitigation measures as acceptable and meeting with the requirements of EFH regulations at 50 CFR Subpart K, 600.920(g). For the 1999 Programmatic Consultation, NOAA Fisheries Service made the following additional recommendations (as numbered within the NOAA Fisheries Service letter of agreement):

(5) When the Live Bottom (Pinnacle Trend) Stipulation is made a part of a pipeline laying permit, MMS shall require that: No bottom-disturbing activities, including anchors from a pipeline laying barge, may be located within 100 ft of any pinnacle trend feature with vertical relief greater than or equal to 8 ft.

(6) When the Topographic Features Stipulation is made a part of a permit that proposes to use a semi-submersible drilling platform, MMS shall require that: No bottom-disturbing activities, including anchors or cables from a semisubmersible drilling platform, may occur within 500 ft of the No Activity Zone boundary.

(7) When the Topographic Features Stipulation is made a part of a permit that proposes exploratory drilling operations, MMS shall require that: Exploratory operations that drill more than two wells from the same surface (surface of the seafloor) location at any one or continuous time and within the 3-Mile Restricted Activity Zone must meet the same requirements as a development operation (i.e., drilling discharges must be shunted to within 10 m (33 ft) of the seafloor).

(8) When the Topographic Features Stipulation is required for any proposed permit around Stetson Bank, now a part of the Flower Gardens Banks National Marine Sanctuary (FGBNMS), the protective requirements of the East and West Flower Garden Banks shall be enforced.

(9) Where there is documented damage to EFH under the Live Bottom (Pinnacle Trend) or Topographic Features lease stipulation, MMS shall coordinate with the NMFS Assistant Regional Administrator, Habitat Conservation Division, Southeast Region for advice. Based on the regulations at 30 CFR Subpart N, 250.200, "Remedies and Penalties," the Regional Director of the MMS may direct the preparation of a case file in the event that a violation of a lease provision (including lease stipulations)

causes serious, irreparable, or immediate harm or damage to life (including fish and other aquatic wildlife) or the marine environment. The conduct of such a case could lead to corrective or mitigative actions.

(10) The MMS shall provide NMFS with yearly summaries describing the number and type of permits issued in the Western and Central Planning Areas, and permits for activities located in the Live Bottom (Pinnacle Trend) and Topographic Features blocks for that year. Also, the summaries shall include a report of any mitigation actions taken by MMS for that year in response to environmental damage to EFH.

The MMS has accepted and adopted these six additional EFH conservation recommendations. In fulfillment of Recommendation No. 10 above, MMS has submitted reports to NOAA Fisheries Service representing summaries of all annual activity related to topographic features lease blocks and live-bottom (pinnacle trend) blocks since the acceptance of the above Programmatic Consultation agreement.

Mitigating Factors

As discussed above, the GOM Fishery Management Council's EFH preservation recommendations for oil and gas exploration and production activities are specified and are currently being followed by MMS as mitigating actions to EFH. The MMS regulations and lease sale stipulations already incorporate many of the suggested EFH conservation recommendations. In some cases, MMS works with other Federal agencies to mitigate effects in an area. In addition, MMS may attach mitigating measures as a condition of approval of an OCS plan or application (exploration, drilling, development, production, pipeline, etc.).

During the active lifetime of platforms, the subsurface portions of any structures in the areas of the proposed lease sales will act as reef material and a focus for many reef-associated species. Fisheries Management Plans specifically describe the use of artificial reefs as EFH. The South Atlantic Fishery Management Council (1998) also describes how manmade reefs are deployed to provide fisheries habitat in a location that provides measurable benefit to man. When manmade reefs are constructed, they provide new primary hard substrate similar in function to newly exposed hard bottom, with the additional benefit of substrate extending from the bottom to the surface. Reef structures of high profile seem to yield generally higher densities of managed and nonmanaged pelagic and demersal species than a more widespread, lower profile natural hard bottom or reef (South Atlantic Fishery Management Council, 1998). Wilson et al. (2003) reported fish densities as much as 1,000 times larger on platforms compared with surrounding mud bottom habitats and even equal to or greater than natural reef habitats such as the Flower Garden Banks. The benefits of artificial reefs created by the installation of energy production platform structures are well documented in Gulf waters off the coast of Texas and Louisiana. More than 250 oil and gas platforms are also used as artificial reefs after they are decommissioned. See **Appendix A.4** for additional information on artificial reefs and the Rigs-to-Reefs development.

3.3. Socioeconomic Activities

3.3.1. Commercial Fishing

Commercial fishing regulations are very detailed and change on a regular basis depending on a variety of factors including stock assessment and catch statistics. Changes can occur on short notice, especially time closures based on allowable catch. A recent change in the allowable length for retention of vermilion snapper was effective July 8, 2005, with a new minimum size limit increased from 10 in to 11 in total length (both recreational and commercial). Federal fishing regulations are not always the same as State fishing regulations. The GOM Fishery Management Council (GMFMC) provides the current information on commercial and recreational fishing rules for U.S. Federal waters of the GOM (GMFMC, 2006b).

Annual and monthly commercial fisheries landings statistics are available on the NOAA Fisheries Service Internet site (USDOC, NOAA Fisheries Service, 2006a). The following information is derived from various analyses of the available data queries at this site. The most recent, complete information on landings and value of fisheries for the U.S. was compiled by NOAA Fisheries Service for 2004. During

2004, commercial landings of all fisheries in the GOM totaled nearly 1.4 billion pounds, valued at over $670 million (USDOC, NOAA Fisheries Service, 2006a). The GOM provides over 34 percent of the commercial fish landings in the continental U.S. (excluding Alaska) on an annual basis.

Menhaden, with landings of about 1.02 billion pounds and valued at $44.9 million, was the most important GOM species in terms of quantity landed during 2004. Landings decreased by 261 million pounds (20%) in the Gulf Coast States compared with 2000. Shrimp, with landings of nearly 257 million pounds and valued at about $367 million, was the most important GOM species in terms of value landed during 2004. The 2004 GOM oyster fishery accounted for over 93 percent of the national total, with landings of 25 million pounds of meats valued at about $61 million. The GOM blue crab fishery accounted for 36 percent of the national total, with landings of 60 million pounds valued at about $41 million (USDOC, NOAA Fisheries Service, 2006a).

Texas' total commercial landings in 2004 were nearly 86 million pounds valued at over $166 million. Shrimp was the most valuable species group landed with all species combined coming to a total weight of over 70 million pounds valued at over $137 million. In addition, during 2004, the following species each accounted for landings valued at over $2 million: blue crab, Eastern oyster, and red snapper. Black drum previously totaled more than $2 million in prior year's annual landings but was valued at only $1.4 million in 2004 (USDOC, NOAA Fisheries Service, 2006a).

Louisiana's total commercial landings in 2004 were 1.1 billion pounds valued at $275 million. Shrimp was the most important fishery landed, with about 134 million pounds valued at $139 million. In addition, during 2004, the following marine species each accounted for landings valued at over $2 million: Atlantic menhaden, black drum, blue crab, Eastern oyster, red snapper, yellowfin tuna, and striped mullet (USDOC, NOAA Fisheries Service, 2006a).

Mississippi's total commercial landings in 2004 were 183.8 million pounds valued at nearly $44 million. Shrimp was the most important fishery landed, with 18.2 million pounds valued at $27 million. In addition, during 2004, the following three species each accounted for landings valued at over $500,000: Atlantic menhaden, blue crab, and Eastern oyster (USDOC, NOAA Fisheries Service, 2006).

Alabama's total commercial fishery landings for 2004 were 26.6 million pounds valued at $37 million. Shrimp was the most important fishery, with about 16.1 pounds landed valued at about $29.2 million. In addition, during 2004, the following species each accounted for landings valued at over $500 thousand: blue crab, Eastern oyster, and Spanish mackerel (USDOC, NOAA Fisheries Service, 2006a).

Total commercial landings for the west coast of Florida in 2004 were 84.3 million pounds valued at $147.9 million. Shrimp was the most important fishery landed, with 18.2 million pounds valued at $ 34.7 million. In addition, during 2004, the following species each accounted for landings valued at over $4 million: stone crab, red grouper, gag, striped mullet, and Caribbean spiny lobster (USDOC, NOAA Fisheries Service, 2006a).

In previous lease sale EIS documents (USDOI, MMS 2001a and 2002a), results from an extensive study by Continental Shelf Associates (CSA, 1997a) was presented, characterizing recreational and commercial fishing east of the Mississippi Delta for the period 1983-1993. This information is quite dated now, but newer compilations are lacking. The details of those conclusions concerning commercial fisheries for the region from 1983 to 1993 are referenced to those previous EIS documents, but some brief summaries are still useful and are included below. This study emphasized the panhandle area of Florida (CSA, 1997a).

Baitfishes accounted for the highest commercial landings in the region during the period 1983-1993. Menhaden contributed the greatest proportion of the entire finfish landings; however, the Florida Panhandle landings for menhaden are orders of magnitude lower than those reported in Louisiana and Mississippi. Coastal pelagic fishes, including king and Spanish mackerel, cobia, and jacks, are an important group to the commercial fisheries of the northeastern GOM. The ladyfish or tenpounder accounted for the highest portion of the coastal pelagic landings. Ranking third in landings over the period 1983-1993, behind the baitfishes and coastal pelagic fishes, were reef fishes. This species group was sought after by more fishers and included many more species than the other groups. The reef fishery also generated the highest valued finfish landings for the region. Reef fishing for snappers, groupers, gray triggerfish, and amberjacks takes place in offshore shelf waters (20-200 m, 66-656 ft) over natural or artificial bottom. Certain deepwater reef fishes such as snowy, yellowedge, and warsaw groupers are fished exclusively in waters off the shelf break. Reef fishes, along with coastal pelagic fishes, are the most sought after groups by fishermen from Alabama and Florida who venture over to the oil and gas platforms off the adjacent States (Hiett and Milon, 2002).

Oceanic pelagic fishes were not landed in high quantities relative to other finfish groups during 1983-1993; however, they were very valuable, ranking second to reef fishes in average dollar value of landings. The most important species, yellowfin tuna and swordfish, were caught primarily by surface longline in oceanic waters offshore of the shelf break. The remaining group of finfishes landed by commercial fishers in the northeastern GOM—the demersal fishes—was taken almost exclusively from inland (estuarine) waters. Many of the demersal species are estuarine-dependent so the quality of the estuarine habitats is critical to maintaining catch levels. Most coastal counties in Alabama and the Florida Panhandle reported sizeable landings of striped mullet. The dominant invertebrate species groups in the northeastern GOM fisheries between 1983 and 1993 were shrimp, oysters, and blue crab. This dominance also occurs in the most recent landings data from 2004. These three species groups were almost exclusively fished in inland (estuarine) waters. The value of shrimp landings exceeded that of all other fish or invertebrate species group. Some royal red shrimping occurs in DeSoto Canyon. Louisiana, Mississippi, and Alabama land primarily brown shrimp, with some white shrimp catches. Florida’s State waters are predominantly pink shrimp habitat. Shrimp were caught with otter trawls, butterfly nets, and beam trawls.

Blue crab was an important component of the invertebrate fishery. The value of the blue crab landings was considerably less than the value of the shrimp landings. The blue crab catch in Mississippi and Alabama is an important part of the U.S. supply of this food commodity; therefore, changes in this catch greatly impact prices. Oyster landings ranked third in weight and second in value behind shrimps for Alabama and northwest Florida in this time period. The static nature of the fishing effort and technology in the oyster industry from 1983 to 1993 is consistent with a lack of productivity. The static character makes it difficult for oyster fishermen to increase profits despite increased fishing efforts.

Recent effects from the hurricanes of 2005 have had substantial impacts on the commercial fishing industry. It was initially believed that the hurricanes of 2005 would have devastating effects on the health and numbers of offshore fish stocks in the GOM. Preliminary results of surveys conducted by NOAA indicate that shrimp and bottom fish abundance was the same or slightly higher after the hurricanes than in the fall of 2004, with shrimp and other valuable species relatively abundant and widely distributed. The NOAA's annual survey of shrimp and bottomfish, which was completed in November 2005, also shows some species, such as the commercially valuable and overfished red snapper, had a higher population in 2005 than in 2004. The survey also found that the Atlantic croaker population doubled in 2005. Thus, it appears that shrimp and finfish resources of the northern Gulf fared much better during and after the hurricanes than did the fishing infrastructure that uses them (Hogarth, 2005). The commercial fisheries landings of the Central Gulf coast were drastically impacted by Hurricanes Rita and Katrina because of the severe impact on coastal port facilities and fishing vessels. There is no conclusive estimate of the number of fishing vessels sunk or driven ashore, but the U.S. Coast Guard initially estimates the number to be between 3,500 and 5,000. This estimate includes nearly 2,400 commercial vessels and 1,200 recreational boats (Hogarth, 2005). Comparing the same states (Western Florida, Mississippi, Alabama, Louisiana, and Texas) and based on figures obtained for September 2005, there was a 97 percent reduction in shrimp landings and a 94 percent reduction in oyster landings, representing a combined loss of over $62 million for the month of September alone. Louisiana catches dropped off entirely for these species. Catches of a number of finfish species were essentially zero in September 2005, including menhaden, blue crab, spiny lobster, stone crab, yellowfin tuna, mullets, and freshwater crawfish. Reef fish catches declined by 44 percent regionwide. These reductions in commercial catches have persisted in most affected areas since September 2005 (December 15, 2005) (Hogarth, 2005).

As opposed to initial concerns about contamination of sediments and fish and shrimp tissue resulting from pollution caused by the hurricanes, NOAA studies found no evidence of hydrocarbons, persistent organic pollutants, or bacterial contamination (Hogarth, 2005; USDOC, NOAA, 2005a). The survey results are consistent with similar findings announced by the Food and Drug Administration, USEPA, and the States of Mississippi, Louisiana, and Alabama by January 2006, which concluded Gulf seafood was deemed safe for human consumption (USDOC, NOAA, 2006e).

Stock Status

The NOAA Fisheries Service reports each year to the Congress and Fishery Management Councils on the status of all fish stocks in the nation. Nationwide, 81 percent of the fish stocks and stock complexes with known status are not subject to overfishing and 72 percent of the stocks and stock complexes with known status are not overfished. ("Overfished" is defined as a stock size that is below a prescribed biomass threshold. "Overfishing" is harvesting at a rate above a prescribed fishing mortality threshold.) The NOAA Fisheries Service has increased the number of assessed stocks over the last several years, and this trend will continue. In 2004, NOAA Fisheries Service completed 84 stock assessments, of which 10 were for stocks not previously assessed.

The number of commercial species designated to be overfished has been reduced from previous years. In 2004, only four major stock groups were overfished in the GOM: red snapper, vermillion snapper, red grouper, and greater amberjack. Twelve commercial species harvested from Federal GOM waters were considered to be at or near an overfished condition at the time of the previous multisale EIS in 2000 (USDOC, NOAA, 2001a). Gag grouper and vermilion snapper were added to the 2001 NOAA Fisheries Services' report's list of stocks for which overfishing is occurring in the GOM. Since that time, gag was removed from the list and greater amberjack was added. Six species—red snapper, vermilion snapper, greater amberjack, Nassau grouper, goliath grouper, and red drum—were listed in the report as overfished in the GOM. Red grouper and king mackerel were removed from the list of species reported as overfished since the previous EIS and greater amberjack was added. The status of another 29 GOM managed fishery species is described as "unknown."

Nearly all species substantially contributing to the GOM's commercial catches are estuarine dependent. The degradation of inshore water quality and loss of GOM wetlands as nursery areas are considered significant threats to commercial fishing (USEPA, 1992 and 1994). Natural catastrophes may change the physical characteristics of offshore, nearshore, and inshore ecosystems and destroy gear and shore facilities. This fact was more than evident with Hurricanes Katrina and Rita. Commercial fishery financial losses will continue for a significant period of time after these major events. Hurricane Andrew, in August 1992, also caused extensive damage to GOM commercial facilities.

Too many shrimp boats in the GOM shrimp fishery have, in the past, resulted in fishing capacity exceeding that required to efficiently harvest the optimum yield of shrimp. Fishing capacity is the ability of a vessel or fleet of vessels to catch fish and is generally defined by the number of vessels in the fleet, the size of each vessel, the technical efficiency of each vessel, and the time each vessel spends fishing. Profits are reduced when vessels expend more effort to harvest the same available resources. The incidental take of juvenile red snapper has been a significant bycatch problem in the GOM shrimp fishery, the resolution of which has challenged fishery managers for many years. Despite the use of bycatch reduction devices (BRD's) in shrimp trawl gear, the fishery has been taking juvenile red snapper at a rate that jeopardizes the success of the red snapper rebuilding plan approved in Amendment 22 to the GOM Reef Fish FMP (GMFMC, 2004b) and, therefore, the red snapper fishery's ability to produce optimum yield population numbers over the long term.

The shrimp fishery is facing several problems: too many vessels given available yields of shrimp; imports of less expensive shrimp from foreign countries, continued decline in ex-vessel price of domestic shrimp; other related fishing needs; increases in fuel prices; excessive costs of marine casualty insurance; regulations regarding the use of turtle excluder devices and by-catch devices; excessive bycatch of finfish; and conflicts with other targeted fisheries. It was believed that BRD's would reduce red snapper bycatch by more than 50 percent, but substantial data have indicated that reduction is only about 25-27 percent, which is not enough to produce mortality reductions necessary to meet stock rebuilding objectives (Gallaway and Cole, 1999). It is not yet evident what the longer-term impacts from the 2005 hurricane devastation of the commercial fishing fleet and shore-based facilities will be on shrimp populations, the bycatch issues, and finfish populations.

During the mid-1980's, directed commercial harvest of red drum in the GOM increased substantially in response to escalating market demands to satiate the growing appetite for "blackened redfish." The offshore fishery continued to escalate in terms of landings of adult fish, which peaked during the 1985-1986 fishing seasons. Stock assessment concluded that red drum were heavily fished prior to moving offshore to spawn and that red drum less than 12 years of age were poorly represented in the offshore spawning population. Continued harvest of adults from Federal waters would further reduce spawning stock and increase the risk of a collapse of the red drum fishery (USDOC, NMFS, 1989). The red drum fishery was closed to all harvest in Federal GOM waters on January 1, 1988. The red drum fishery has remained closed through 2006.

Red and vermilion snapper resources in the GOM are believed to be severely overfished from both directed and bycatch fisheries. Red snapper is the most important species off the Central Gulf Coast in the reef fish complex managed under an FMP in terms of value and historical landings. Red snapper is the second and vermillion the third most important snapper species off the Florida west coast after yellowtail snapper. In recent years, fishers have reported seeing and catching many more and larger red snapper, and the species appears to be returning to the waters of the Eastern Gulf. However, the estimate of the resulting spawning potential ratio (SPR) has remained well below the overfishing limit (threshold) (SPR = spawning potential per recruit under a given fishing regime relative to the spawning potential per recruit with no fishing) (Schirripa, 1999). With several years of strong recruitment, one would expect the catches to improve. However, since newly recruited year-classes take some time to contribute significantly to the reproductive potential of the stock, it also takes time before these year-classes generate a corresponding increase in their spawning potential. This is particularly true when the spawning stock is composed of a large number of year-classes. On October 30, 2003, NOAA Fisheries Service determined that the GOM vermilion snapper fishery was overfished and undergoing overfishing. Amendments to the Reef Fish Fishery Management Plan for stock rebuilding were created for both red and vermilion snapper (Amendments 22 and 23, respectively) (GMFMC, 2004b and c). According to the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSFCMA), overfished stocks must be rebuilt to maximum sustainable yield (MSY) abundance levels in the shortest timeframe possible, taking into account the status and biology of the stock, the needs of fishing communities, international agreements, and ecological interactions.

Although stone crabs occur throughout the GOM, the majority of fishing occurs along the Gulf Coast of Florida. The majority of landings have been reported almost exclusively (98% by weight) in Gulf Coast counties. The stone crab is a unique fishery since stone crabs are not killed but rather the claws are removed and the crabs are returned alive to the water. Crabs that survive de-clawing can regenerate claws through molting, allowing new claws to be harvested. The biological linkage between landings of claws and the underlying stock of crabs has not been fully assessed because of the lack of a statewide, fishery-independent sampling program. The major concern of the stone crab fishery is whether harvest has reached or exceeded maximum sustainable yield. Until recently, the fishery has been expanding in terms of increasing catch within traditional fishing areas, as well as previously unfished or underfished regions although landings leveled off during the 1990's. The GMFMC has considered limitations on the number of fishermen and traps in the stone crab fishery in the recent past, but no actions are pending.

Spiny lobster fishing is practiced almost exclusively in the Eastern GOM. There are no certain measures of stock abundance. Landings were combined with lengths and sexes to estimate the number of lobsters landed by ages and season in a relatively recent stock assessment by Muller et al. (2000). It was determined that the lobster fishery continues to fluctuate without trend as it has done for the last 30 years. Landings increased in the 2000 season after a decline in the 1998-1999 season. In 2004, landings remained substantial, with a total of over 4.5 million pounds valued at over $20.6 million.

The coastal migratory pelagic FMP addresses a number of species. Two of the more important species are king and Spanish mackerels. Both species have been extensively overfished in the past. In 1985, assessment information became available indicating that there were separate migratory groups for the GOM and Atlantic areas with a mixing zone off southeast Florida. This information also indicated that the Gulf group king mackerel were overfished. Recreational catches have dominated the Gulf group king mackerel fishery. Significant overruns of total allowable catch occurred until approximately 1997, primarily from the recreational fishery that was not subject to quota limits. Since 1997, the recreational catch has declined, while the commercial catch has remained relatively stable (GMFMC, 2004a). Based on recent stock definitions for overfishing and the actural condition of Gulf group king mackerel, the stock would not have been considered as either overfished or undergoing overfishing since at least 2000, and it is not listed in either of these categories for 2005. Landings of Spanish mackerel declined significantly to less than 3 million pounds in the mid 1990's because of the loss of markets and the gill net ban in Florida. Landings increased to approximately 4 million pounds in 1999-2000 and 2000-2001 (GMFMC, 2004a). Since the net ban in 1995, recreational catches have generally been more than double the commercial catches. The Spanish mackerel stock is not considered as either overfished or undergoing overfishing. Recent catch levels are less than half of the recommended total allowable catch (TAC) (GMFMC, 2004a).

In the mid-1980's, Atlantic swordfish were considered to be in or near a state of growth overfishing. In 1999, NOAA Fisheries Service implemented a number of regulations that affected swordfish fishers, including a prohibition on the use of driftnets in the swordfish fishery, and regulations to aid in tracking swordfish trade including dealer permitting and reporting for all swordfish importers, a documentation scheme that indicated the country of origin and flag of the vessel, and a prohibition on importing swordfish less than the minimum size. The same year, NOAA Fisheries Service produced a new fishery management plan that took the place of the previous FMP produced by the South Atlantic Fishery Management Council. In August 2005, a draft Consolidated Atlantic Highly Migratory Species Fishery Management Plan was published (USDOC, NOAA Fisheries Service, 2005b). This new FMP includes several alternatives for pelagic longline closures in the GOM. Commercial landings of swordfish increased steadily in the 1990's and a total of 900,593 pounds were landed in 2004 (USDOC, NOAA Fisheries Service, 2006a). At present, live bait use is prohibited in the GOM. Two longline closure areas are described below.

Blue marlin and white marlin are believed to be at or near the point of full exploitation. Both species (considered an Atlantic stock) are considered overfished and are undergoing overfishing. The latest stock assessments for Atlantic blue marlin and Atlantic white marlin were conducted in 2000. The assessment for blue marlin was slightly more optimistic than the 1998 assessment; however, productivity is lower than previously estimated. Although blue marlin landings in 1999 were reduced by 29 percent from 1996 levels, these reductions are not sufficient to rebuild the stock. Recent assessments for white marlin are more pessimistic. Given that the stock is severely depressed, the Standing Committee for Research and Science (SCRS) concluded that the International Commission for the Conservation of Atlantic Tunas (ICCAT) should take steps to reduce the catch of white marlin as much as possible (USDOC, NOAA Fisheries Service, 2006b).

The only tuna species landed in any significant volume in the GOM is the yellowfin tuna, with over 3.5 million pounds landed in 2004 (USDOC, NOAA Fisheries Service, 2006a). The last full assessment was conducted for yellowfin tuna in 2003 applying various age structured and production models to the available catch data through 2001 (USDOC, NOAA Fisheries Service, 2006b). For the Atlantic stock as a whole, total catches since 2001 have been declining; but, without a new assessment it is not clear whether or not this reflects decreases in fishing effort and fishing mortality. In the GOM alone, landings have fluctuated with a recent high occurring in 2002 of over 4.2 million pounds, but the latest data for 2004 ranked third in the last four years and surpassed 2001 landings by 602,685 pounds. The SCRS recommended that there be no increase in the level of effective fishing effort exerted on Atlantic yellowfin tuna, over the level observed in 1992.

Stock assessments were conducted by NOAA Fisheries Service for the large and small coastal shark complexes in 2002. The large coastal shark complex is considered to be overfished and overfishing is occurring. The complex includes numerous species such as the silky, tiger, bull, spinner, lemon, nurse, and the several hammerhead species, but the status determination was based only on the sandbar and blacktip shark species. The blacktip shark resulted in the highest landings by weight and value for the GOM in 2004 with over 1 million pounds landed valued at $203,445 (USDOC, NOAA Fisheries Service, 2006a); however, when considered individually, it is not considered overfished. The sandbar shark is the only other species with significant GOM landings in 2004 (772,800 pounds for the entire GOM). This species is not considered to be overfished and is in a rebuilding phase, but overfishing is still occurring.

Because collection of stony corals (Scleractinia) and sea fans (Gorgonacea) is prohibited in U.S. waters of the GOM, harvest is minimal and the majority of collections are for research purposes. The NOAA Fisheries Service reports a commercial harvest of 0 tons from Gulf waters between 1992 and 2000, the last year for which data are available. Thus, corals are generally considered a nonconsumptive resource (GMFMC, 2004a).

"Fishing" for soft coral octocorals is presently below the limits of maximum yield. Amendment 3 to the FMP for coral and coral reefs (effective November 9, 1995) with supplementary documents was prepared by the GMFMC to provide additional management to the harvest of live rock in the GOM. Similar to an earlier amendment by the South Atlantic FMC that applied only to live rock on the Atlantic side of Florida, this amendment considered further live rock regulation, including an annual quota during phase-out, revision of trip limits, a closed area off Florida's Panhandle, redefinition of allowable octocorals, and limited personal use live rock harvest.

GOM Area Closures

Grouper species can be overfished because they aggregate in great numbers year after year in the same locations during spawning; during that time the males are especially susceptible to being caught. The NOAA Fisheries Service hopes to spare the spawning population by using closed seasons and Marine Protected Areas (MPA) as a management tool. Two MPA's have been designated in the west Florida shelf (**Figure 3-10**); the MPA's are now closed to all fishing except for pelagics. They are named the Madison and Swanson site (115 nmi^2), south of Panama City, Florida, and Steamboat Lumps (104 nmi^2), west of Tarpon Springs, Florida. The two grouper reserves went into effect on June 19, 2000. In addition, a sunset provision has been added after four years so that the effects of the closed areas can be evaluated. Both of the areas are along the 70- to 80-m (230- to 262-ft) depth contour. The Madison and Swanson site south of Panama City is a high-relief site. Steamboat Lumps, west of Tarpon Springs, is the lower portion of the original 423-nmi^2 closed-area proposal. It is a low-relief site that has been reported by fishermen to be a good area for gag spawning. Both of these sites are outside the area considered for leasing in this document, but they do remain in effect and have impacted the routing of pipelines in the past.

In 1999, numerous longline time and area closures in the GOM were proposed through the proposed Atlantic Highly Migratory Species Conservation Act. Only two longline closure areas resulted and on August 4, 2000, NOAA Fisheries Service announced new regulations to reduce bycatch and bycatch mortality in the pelagic longline fishery. Two rectangular areas in the GOM (1 of which lies over a portion of the region known as DeSoto Canyon) were closed year-round to pelagic longline fishing beginning November 1, 2000. These closed areas cover 32,800 mi^2 (**Figure 3-11**). This region has been identified by NOAA Fisheries Service as a swordfish nursery area where there has historically been a low ratio of swordfish kept to the number of undersized swordfish discarded, which over the period of 1993-1998 has averaged less than one swordfish kept to one swordfish discarded. The area closure is expected to produce approximately a 4 percent reduction in GOM and Atlantic undersized swordfish bycatch. The DeSoto Canyon area coordinates are as follows:

Upper Area

North boundary:	30^o N. latitude
South boundary:	28^o N. latitude
East boundary:	86^o W. longitude
West boundary:	88^o W. longitude

Lower Area

North boundary:	28^o N. latitude
South boundary:	26^o N. latitude
East boundary:	84^o W. longitude
West boundary:	86^o W. longitude.

3.3.2. Recreational Fishing

The primary source for marine recreational fisheries data in U.S. waters is the Marine Recreational Fisheries Statistics Survey (MRFSS) conducted by NOAA's Fisheries Service (USDOC, NOAA Fisheries Service, 2005). This survey combines random telephone interviews and onsite intercept surveys of anglers to estimate recreational catch and effort for inland, State, and Federal waters. In the GOM, surveys are conducted in western Florida, Alabama, Mississippi, and Louisiana. In addition, Texas conducts its own survey of recreational fishing (Anderson and Ditton, 2004), and these data, which are for State FY 2001, are included when available. Additional information on recreational fishing is available in Hiett and Milon (2002).

Tables 3-12, 3-13, and 3-14 show the MRFSS GOM data for 2003. Over 6 million people engaged in some form of recreational fishing in these states. Of the four states, western Florida had the highest number of anglers and fishing trips in 2003, followed (in descending order by number of trips) by Louisiana, Alabama, and Mississippi. The most common mode of fishing in all GOM States was private/rental boats, comprising over 50 percent of the trips in each State. This was followed closely by fishing from shore and distantly by fishing from charter vessels.

In 2003, the percentage of effort expended in inland, State, and Federal waters varied by State. In Mississippi and Louisiana, over 90 percent of trips were made in inland waters as opposed to State and Federal ocean waters. In Florida and Alabama, the percentage of trips made in State ocean waters (45.4% and 38.2%, respectively) was much higher than the other two states.

In State FY 2001, a total of 1,382,015 Texas resident fishing licenses were purchased (Anderson and Ditton, 2004). An estimated 1,160,893 (or 84%) of these license holders actually fished one or more days in Texas during the year. Of those who fished, 82 percent participated in freshwater fishing and 52 percent participated in saltwater fishing. Freshwater anglers fished an average of 26 days, with 10 (or 38%) of these days involving fishing lakes and reservoirs from a boat, while saltwater anglers fished an average of 18 days, with 8 (or 44%) of these days involving fishing saltwater bays from a boat (Anderson and Ditton, 2004).

Fishing in State and offshore waters often occurs around artificial structures. Off Alabama, Mississippi, Louisiana, and Texas, these structures include oil and gas platforms. A recent MMS study estimated that during 1999 there were 980,264 fishing trips taken within 300 ft of an oil or gas structure or an artificial reef created from such structures (Hiett and Milon, 2002). This represented approximately 22 percent of the total (4.4 million) marine recreational fishing trips taken that year in the Gulf from Alabama through Texas. The study found that approximately $159.7 million in direct expenditures were associated with these visits.

The top species commonly caught by recreational fishers in the MRFSS Gulf Coast States are illustrated in **Table 3-12**. Herrings and spotted sea trout, both inland species, were the most common fish caught by recreational anglers in the GOM during 2003. The estimated catch for herrings was over 36 million fish, while over 28 million spotted sea trout were caught. Other important inland species include saltwater catfishes, red drum, and sheepshead. In offshore oceanic waters of the GOM, the most important species in terms of pound caught were red snapper, mycteroperca grouper, king mackerel, dolphin, and great amberjack.

When freshwater anglers in Texas were asked to name the fish they prefer to catch, 40 percent indicated a first choice preference for black basses, with an additional 13 percent indicating largemouth bass (Anderson and Ditton, 2004). Other species preferred by freshwater anglers included catfishes, crappie, and temperate basses (white bass, striped bass, and hybrid striped bass). Most saltwater anglers in Texas (38%) indicated a first choice preference for red drum, followed by speckled trout, the drum family, and flounder (Anderson and Ditton, 2004).

Hurricanes Katrina and Rita impacted recreational fishing from the Florida Panhandle to the Texas border, with additional impacts felt in southern Florida. The hurricanes had a major impact on the supporting infrastructure that anglers require to go fishing (e.g., bait shops, docks and marinas, lodging, fuel and ice facilities, etc.). In addition to damages to boats and facilities, revenue losses associated with lost markets of products or services are occurring. When considered on a regional basis, these lost market channels constitute a considerable reduction in the levels of economic activity, income generation, employment creation, and tax collections.

Most of the charter fishing industry in Louisiana was based in the eastern portion of the State and was hit hard by Hurricane Katrina, particularly the Venice area, which experienced a nearly complete loss of onshore marina facilities and harbored boats (Thomas, 2005). Most residents of fishing communities in lower St. Bernard and Plaquemines Parishes lost their homes; nearly all fishing camps in these regions were damaged and many were completely destroyed (Thomas and Caffey, 2005).

The estimated damages to the resident Mississippi recreational and charter boat fleet totaled to $159 million and $2.6 million, respectively (Mississippi State University Extension Service, 2006a). There were 37 marinas in the three coastal counties when Hurricane Katrina landed on the Mississippi Gulf Coast, and all of them were impacted by the hurricane, with total damages reaching $41.38 million. All the live bait dealers were also affected, with damages totaling $4.17 million (Mississippi State University Extension Service, 2006a). Employment levels have also been dramatically affected as follows: charter boat employment has shrunk to 15.2 percent of its pre-Katrina level; marina employment shrunk to 18.9 percent of its pre-Katrina level; and live bait employment dropped to 16.7 percent of its pre-Katrina level (Mississippi State University Extension Service, 2006b).

The NOAA Fisheries Service is currently trying to assess the damages to marine-related infrastructure in the Gulf communities and is conducting a survey and analysis of the recreational fisheries impacts (USDOC, NOAA Fisheries Service, 2005a). Mississippi State University is also conducting research on the impacts of Hurricane Katrina on coastal Mississippi marine resources (Mississippi State University, 2005). The MMS will continue to monitor data sources and will include updated data and information in future documents and analyses as they become available.

3.3.3. Recreational Resources

The northern GOM coastal zone is one of the major recreational regions of the U.S., particularly in connection with marine fishing and beach-related activities. The shorefronts along the Gulf Coasts of Florida, Alabama, Mississippi, Louisiana, and Texas offer a diversity of natural and developed landscapes and seascapes. The coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes are extensively and intensively used for recreational activity by residents of the Gulf South and tourists from throughout the Nation, as well as from foreign countries. Publicly owned and administered areas (such as national seashores, parks, beaches, and wildlife lands), as well as specially designated preservation areas (such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers), attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments (such as resorts, marinas, amusement parks, and ornamental gardens) also serve as primary interest areas and support services for people who seek enjoyment from the recreational resources associated with the GOM.

Recreation and tourism are major sources of employment along the Gulf Coast. **Tables 3-15 and 3-16** present employment in tourism-related industries in 2002. To estimate travel/tourism related industries, a review of the 2002 county business patterns data was conducted (USDOC, Bureau of the Census, 2002). Employment data were derived from various travel-related industries including food and beverage stores, gas stations, general merchandise stores, passenger air transportation, transit and ground passenger transportation, scenic and sightseeing transportation, passenger car rental, travel arrangement and reservation services, arts/entertainment/recreation, and accommodation and food services.

The MMS defined 13 Economic Impacts Areas (EIA's) (**Table 3-17** and **Figure 3-12**). The employment in these industries was calculated for the EIA's (**Table 3-16**). The greatest concentration of tourism-related employment occurs in Florida, particularly in EIA's FL-3 and FL-4. Within these impact areas, tourism-related employment is concentrated in the Miami and Tampa-St. Petersburg LMA's. The Houston-Galveston and New Orleans LMA's (EIA's TX-3 and LA-4, respectively) also have a relatively high amount of tourism-related employment.

The 1999-2000 National Survey on Recreation and the Environment (NSRE) is the first national survey to include a broad assessment of the Nation's participation in marine recreation (USDOC, NOAA, 2005b). Marine recreation is defined as coastal and ocean participation plus the Great Lakes participation in at least 1 of 19 activities/settings. Participation is defined as the number of people that performed the activity in each State and includes people that may live in any State. According to NSRE 2000, Florida was the number one destination for marine recreation. Over 22 million participated in some form of marine recreation in Florida. Texas ranked fifth, with slightly under 6.2 million participants. Participation was lower in Alabama, Louisiana, and Mississippi (2.5 million, 2.2 million, and 1.8 million, respectively) but still significant. The number one activity/setting for marine recreation was visiting beaches.

Beaches are a major recreational resource that attracts tourists and residents to the Gulf Coast for fishing, swimming, shelling, beachcombing, camping, picnicking, bird watching, and other activities. The scenic and aesthetic value of Gulf Coast beaches plays an important role in attracting visitors to the coastal zone. According to NSRE 2000 data on beach visitation by state in which the beach is located, Florida ranks number one with 15.2 million participants. Florida has the nation's second largest coast, approximately 8,400 mi of tidally influenced shoreline. Two distinct waterfronts – the Atlantic Ocean and GOM – have approximately 825 mi (1,328 km) of sandy beach. The USEPA reports 408 beaches in 22 coastal counties along the Gulf (USEPA, 2004b). Tourism has been Florida's major source of income for many years. Although it initially attracted visitors from the Northeastern states during the winter months, it is now a year-round vacationland visited by tourists from every state, Latin America, and also from Canada and other foreign countries. Tourists visiting Florida's beaches in 2000 spent approximately $21.9 billion, resulting in an indirect economic effect of $19.7 billion and a total economic impact of $41.6 billion (Florida Sea Grant, 2005).

Texas has 624 mi (1,004 km) of coastline on the GOM, approximately 480 mi (772 km) of which are beach (NRDC, 2004). The USEPA reports 166 beaches in 14 counties (USEPA, 2004b). Virtually the entire Texas coast is bordered by a barrier island system that separates the GOM from the bays. Although fishing activity is heavy in the bay systems, most swimming occurs on the Gulf beaches. According to NSRE 2000 data on beach visitation, Texas ranks fifth with 3.9 million participants. Most coastal travel occurs in Harris, Nueces, Cameron, and Galveston Counties.

According to the Alabama Department of Environmental Management (ADEM), the State has approximately 50 mi (80 km) of Gulf Beach (32 mi in Baldwin County and 16 mi on Dauphin Island) and an estimated 65-70 mi (105-113 km) of bay beaches, including Mobile Bay, Mississippi Sound, Perdido Bay, and Wolf Bay (ADEM, 2005). The USEPA reports a total of 95 coastal beaches in Alabama, 90 of which are in Baldwin County (USEPA, 2004b). In 2003, Baldwin County had a travel-related economic impact on Alabama totaling more than $1.8 billion (EDPA, 2005). According to NSRE 2000 data on beach visitation, over 1.2 million participants visited Alabama beaches.

Including all bays, inlets, and promontories, Mississippi's GOM coastline has a total length of 359 mi. The coastline is extremely irregular. A series of low barrier islands lay offshore, of which the largest are Cat, Ship, Horn, and Petit Bois Islands. The USEPA reports 21 coastal beaches in the three Mississippi Gulf Coast counties: 3 in Hancock, 12 in Harrison, and 6 in Jackson (USEPA, 2004b). According to NSRE 2000 data on beach visitation, over 1.0 million participants visited Mississippi beaches.

Although there are a variety of beach activities along the Gulf Coast, the growth of casinos in Mississippi and southwest Louisiana has attracted many visitors since the 1990's. Before the 2005 hurricane season, Mississippi was the third largest casino market in the U.S., behind Las Vegas, Nevada, and Atlantic City, New Jersey. There were 28 casinos in Mississippi that generated nearly $2.7 billion in revenue. Approximately $331.7 million was generated in tax revenues. The taxes were allocated among housing, education, transportation, health care services, and youth counseling programs. Before Hurricane Katrina, it was estimated that Mississippi casinos admitted over 54.8 million people in 2003 (AGA, 2003). There were approximately 12 casinos in Mississippi's Gulf Coast area – 1 in Bay St. Louis, 2 in Gulfport, and 9 in Biloxi. Gulf Coast casinos generated $1.15 billion in 2001 and employed nearly 17,000 people (Garrett, 2003). Biloxi casinos, in particular, accounted for $887 million (77%).

The gaming industry is currently in a state of flux after Hurricanes Katrina and Rita. For example, only 3 out of the 12 casinos that existed before Hurricane Katrina were open as of March 2006 in the Biloxi-Gulfport, Mississippi metropolitan area. However, a large amount of casino rebuilding is underway as a result of legislative action approved in the fall of 2005, allowing shore-based rather than riverboat gambling. With no restrictions on size, damaged casinos along the Mississippi Gulf Coast are being rebuilt with even larger gaming facilities than existed before the hurricane. It is estimated that 7-10 casinos will open in the Biloxi-Gulfport area by the end of 2006. One new and three expanded casinos are expected to open by the end of 2007. Hotel and restaurant construction and investment should demonstrate similar patterns to the current casino expansion in the area. This area is already showing positive economic recovery signals. For example, sales tax collections in March 2006 in Harrison County, Mississippi, were 29.6 percent higher than the March 2005 collections (Scott, 2006). The monthly gross gaming revenues in Mississippi have increased from 54 percent of 2005 revenues in February 2006 to 60.6 percent of 2005 revenues in June 2006 (MS Governor's Office of Recovery Renewal, 2006). Although several major casinos in the Lake Charles, Louisiana, area suffered damage from Hurricane Rita, the gaming industry experienced an increase in employment between April 2005 and April 2006 (Scott, 2006).

Louisiana has about 397 mi of general coastline and 7,721 mi of tidal shoreline, behind only Alaska and Florida in length of marine shore. Louisiana's coastline is primarily wetlands, and much of the State's 7,656 mi^2 of estuarine water is largely inaccessible to swimmers. The USEPA reports 16 coastal beaches in seven counties/parishes along the Gulf, half of which are in Cameron Parish (USEPA, 2004b). Louisiana beaches are primarily used by local and State residents, and use is highest during the spring and summer seasons (Louisiana Dept. of Health and Hospitals, Office of Public Health Louisiana, 2005). The NSRE 2000 data on beach visitation estimates over 600,000 participants visited Louisiana beaches.

There is substantial recreational activity associated with the presence of oil and gas structures in the GOM from Alabama through Texas, and these activities have a considerable economic impact. A recent MMS study estimated that a total of 980,264 fishing trips were taken within 300 ft of an oil or gas structure or an artificial reef created from such structures during 1999 out of a total 4.48 million marine recreational fishing trips in the Gulf from Alabama through Texas (Hiett and Milon, 2002). In addition, the study found that there were 83,780 dive trips near oil and gas structures out of a total 89,464 dive trips. Overall, the study estimated a total of $172.9 million in trip-related costs for fishing and diving near oil and gas structures, with $13.2 million in trip expenditures for diving and $159.7 million associated with trip expenses for recreational fishing.

Table 3-32 presents data from the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation for the five Gulf States (USDOI, FWS and USDOC, Bureau of the Census, 2001). In 2001, there were 2.5 million residents and nonresidents 16 years old and older who hunted in the Gulf States. These hunters spent approximately $3.4 billion, with $1.1 billion being spent on trip-related expenses such as food, lodging, and transportation and $2.3 billion being spent on equipment. Texas was the leading hunting state, accounting for 47 percent (1.2 million) of the total number of hunters and 45 percent ($1.5 billion) of the total expenditures. State resident hunters numbered 2.1 million, accounting for 84 percent of the total, while 400,000 non-residents hunted in these States.

Nine million U.S. residents 16 years old or older fed, observed, or photographed wildlife in the Gulf States in 2001. These participants spent roughly $3.9 billion, with $1 billion being spent on trip-related expenses such as food, lodging, and transportation and $2.9 billion being spent on equipment. Approximately 66 percent of participants (5.9 million) enjoyed their activities close to home and are called “residential” participants. Those persons who enjoyed wildlife at least 1 mi from home are referred to as “nonresidential” participants. Texas and Florida were the leading wildlife watching States, each accounting for 36 percent (3.2 million participants) of the total number of participants in the Gulf.

The previous discussions describe the tourism and recreation baseline for the GOM prior to the impacts of Hurricanes Katrina and Rita. Both of these storms caused extensive adverse impact to tourism and recreation throughout the Gulf. These storms destroyed recreational beaches, public piers, hotels, casinos, marinas, recreational pleasure craft and charter boats, and numerous forms of other recreational infrastructure. Of the 13 casino-barge structures present along the Mississippi coast prior to Hurricane Katrina, most suffered severe external damage, seven broke completely free of their moorings, two partially broke free and damaged adjoining structures, one sank, and one was deposited inland by the storm surge (National Institute of Standards and Technology, 2006). The full extent of impacts to the tourism and recreation by the hurricanes has yet to be fully quantified, but it will likely take years for tourism and recreation to return to pre-hurricane levels. The MMS will update tourism and recreation data as they become available.

3.3.4. Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 250.105). The Archaeological Resources Regulation (30 CFR 250.194) provides specific authority to each MMS Regional Director to require archaeological resource surveys, analyses, and reports. Surveys are required prior to any exploration or development activities on leases within areas determined to have a high potential for archaeological resources (NTL 2005-G07 and NTL 2006-G07).

3.3.4.1. Historic

With the exception of the Ship Shoal Lighthouse structure, historic archaeological resources on the OCS consist of historic shipwrecks. An historic shipwreck is defined as a submerged or buried vessel, at least 50 years old, that has foundered, stranded, or wrecked and is presently lying on or embedded in the seafloor. This includes vessels that exist intact or as scattered components on or in the seafloor.

The MMS contracted three studies (Garrison et al., 1989; Pearson et al., 2003) aimed at modeling areas in the GOM where historic shipwrecks are most likely to exist. The 1977 study concluded that two-thirds of the total number of shipwrecks in the northern Gulf lie within 1.5 km (1 mi) of shore and most of the remainder lie between 1.5 and 10 km (1 and 6 mi) of the coast (CEI, 1977). The 1989 study found that changes in the late 19th- and early 20th-century sailing routes increased the frequency of shipwrecks in the open sea in the Eastern Gulf to nearly double that of the Central and Western Gulf (Garrison et al., 1989). The Garrison study also found the highest observed frequency of shipwrecks occurred within areas of intense marine traffic, such as the approaches and entrances to seaports and the mouths of navigable rivers and straits.

The 2003 study benefited from the experience of almost 15 years of high-resolution shallow hazard surveys in lease blocks (a typical lease block is 9 mi^2 (5,760 ac)) and along pipeline routes. Some of these surveys (almost exclusively for pipeline routes) were conducted in deep water. Several of these pipeline hazard surveys succeeded in locating historic ships, ranging in age from an 18th-century armed sailing ship to a World War II German U-boat.

Historic shipwrecks have, to date, been discovered through oil industry sonar surveys in water depths up to 6,500 ft. In fact, in the last 5 years, over a dozen shipwrecks have been located in deep water and nine of these ships have been confirmed visually as historic vessels. Many of these wrecks were not previously known to exist in these areas from the historic record. Taking these discoveries into account, the 2003 study then recommended including some deepwater areas, primarily on the approach to the Mississippi River, among those lease areas requiring archaeological investigation. With this in mind, MMS recently revised its guidelines for conducting archaeological surveys and added about 1,200 lease blocks to the list of blocks requiring an archaeological survey and assessment. These requirements are posted on the MMS website under NTL 2005-G07 and NTL 2006-G07. Since implementation of these new lease blocks on July 1, 2005, at least 10 possible historic shipwrecks have been reported in this area.

Pearson et al. (2003) lists numerous shipwrecks that fall within the CPA and WPA. Many of these reported shipwrecks may be considered historic and could be eligible for nomination to the National Register of Historic Places. Most of these wrecks are known only through the historical record and, to date, have not been located on the ocean floor. The MMS Shipwreck Database currently lists 911 wrecks in the CPA and 494 wrecks in the WPA. These wrecks are listed by planning area in **Table 3-33**. This list should not be considered an exhaustive list. Regular reporting of shipwrecks did not occur until late in the 19th century, and losses of several classes of vessels, such as small coastal fishing boats, were largely unreported in official records.

Submerged shipwrecks off the coasts of Texas, Louisiana, Mississippi, and Alabama are likely to be moderately well preserved because of the high sediment load in the water column from upland drainage and wind and water erosion. Wrecks occurring in or close to the mouth of bays would have been quickly buried by transported sediment and therefore protected from the destructive effects of wood-eating shipworms (*Teredo navalis*) or storms (Anuskiewicz, 1989; page 90). A good example of this type of historic wreck is the *la Belle* a shallow draft French sailing vessel classified as a *barque longue* lost in 1686 and discovered in Matagorda Bay, Texas, in 1995. Wrecks occurring in deeper water also have a moderate to high preservation potential. In the deep water, temperature at the seafloor is extremely cold, which slows the oxidation of ferrous metals. The cold water would also eliminate wood-eating shipworms. There have been several recent deepwater shipwreck discoveries in the CPA off the mouth of the Mississippi River. These wrecks were discovered by the oil and gas industry during required MMS remote-sensing surveys.

The discoveries include two late 18th- to early 19th-century wooden sailing vessels, one lying in nearly 2,700 ft of water and the other in 4,000 ft of water. There are also several World War II casualties located in deep water off the mouth of the Mississippi River (e.g., *Alcoa Puritan, GulfPenn, Halo, Virginia, Robert E. Lee*, and the German submarine U-166). All of these wrecks have been investigated using a remotely-operated vehicle from a surface vessel and are in an excellent state of preservation.

Aside from acts of war, hurricanes cause the greatest number of wrecks in the Gulf. Wrecks occurring as a result of an extremely violent storm are more likely to be scattered over a broad area. The wreckage of the 19th-century steamer *New York*, which was destroyed in a hurricane, lies in 16 m (52 ft) of water and has been documented by MMS (Irion and Anuskiewicz, 1999) as scattered over the ocean floor in a swath over 1,500 ft long. Shipwrecks occurring in shallow water nearer to shore are more likely to have been reworked and scattered by subsequent storms than those wrecks occurring at greater depths on the OCS. Historic research indicates that shipwrecks occur less frequently in Federal waters. These wrecks are likely to be better preserved, less disturbed, and, therefore, more likely to be eligible for nomination to the National Register of Historic Places than are wrecks in shallower State waters.

Recent hurricane activity in the GOM is certain to have impacted historic shipwrecks in shallow water. A good faith effort was made to identify any impacts to known historic shipwrecks; however, no such information was identified. Yet, it is almost certain that any shipwrecks within the path of Hurricanes Katrina or Rita in shallow water were impacted to some extent by these storms.

3.3.4.2. Prehistoric

Available evidence suggests that sea level in the northern GOM was at least 90 m, and possibly as much as 130 m (427 ft), lower than present sea level during the period 20,000-17,000 years Before Present (B.P.) (Nelson and Bray, 1970). Sea level in the northern Gulf reached its present stand around 3,500 years B.P. (Pearson et al., 1986).

During periods that the continental shelf was exposed above sea level, the area was open to habitation by prehistoric peoples. The advent of early man into the GOM region is currently accepted to be around 12,000 years B.P. (Aten, 1983). The sea-level curve for the northern GOM proposed by Coastal Environments, Inc. (CEI) suggests that sea level at 12,000 B.P., would have been approximately 45-60 m (148-197 ft) below the present day sea level (CEI, 1977 and 1982). On this basis, the continental shelf shoreward of the 45- to 60-m (148- to 197-ft) bathymetric contours has potential for prehistoric sites dating after 12,000 B.P. Because of inherent uncertainties in both the depth of sea level and the entry date of prehistoric man into North America, MMS adopted the 60-m (197-ft) water depth as the seaward extent for archaeological site potential in GOMR.

Based on their 1977 baseline study, CEI (1977) proposed that sites analogous to the types of sites frequented by Paleo-Indians can be identified on the now-submerged shelf. Geomorphic features that have a high potential for associated prehistoric sites include barrier islands and back-barrier embayments, river channels and associated floodplains and terraces, and salt-dome features. Remote-sensing surveys have been very successful in identifying these types of geographic features, which have a high potential for associated prehistoric sites. Recent investigations in Louisiana and Florida indicate the mound-building activity by prehistoric inhabitants may have occurred as early as 6,200 B.P. (cf. Haag, 1992; Saunders et al., 1992; Russo, 1992). Therefore, manmade features, such as mounds, may also exist in the shallow inundated portions of the OCS.

Regional geological mapping studies by MMS allow interpretations of specific geomorphic features and assessments of archaeological potential in terms of age, the type of system the geomorphic features belong to, and geologic processes that formed and modified them. The potential for site preservation must also be considered as an integral part of the predictive model. In general, sites protected by sediment overburden have a high potential for preservation from the destructive effects of marine transgression. The same holds true for sites submerged in areas subjected to low wave energy and for sites on relatively steep shelves, which were inundated during periods of rapid rise in sea level. Though many specific areas in the Gulf having a high potential for prehistoric sites have been identified through required archaeological surveys, industry generally has chosen to avoid these areas rather than conduct further investigations.

Holocene sediments form a thin veneer or are absent over the majority of the continental shelf off western Louisiana and eastern Texas (USDOI, MMS, 1984). Many large, late Pleistocene, fluvial systems (e.g., the Sabine-Calcasieu River Valley) are within a few meters of the seafloor in this area. Further to the south and west, a blanket of Holocene sediments overlays the Pleistocene horizon. In the Western Gulf, prehistoric sites representing the Paleo-Indian culture period through European contact have been reported. The McFaddin Beach site, east of Galveston in the McFaddin National Wildlife Refuge, has produced late Pleistocene megafaunal remains and lithics from all archaeological periods, including a large percentage of Paleo-Indian artifacts (Stright et al., 1999). A study funded by MMS to locate prehistoric archaeological sites in association with the buried Sabine-Calcasieu River Valley was completed in 1986 (CEI, 1986). Five types of relict landforms were identified and evaluated for archaeological potential. Coring of selected features was performed, and sedimentary analyses suggested the presence of at least two archaeological sites.

Surveys from other areas of the western part of the CPA have produced evidence of floodplains, terracing, and point-bar deposits in association with relict late Pleistocene fluvial systems. Prehistoric sites associated with these features would have a high potential for preservation. Salt diapirs with bathymetric expression have also been recorded during lease-block surveys in this area. Solution features at the crest of these domes would have a high potential for preservation of associated prehistoric sites. The Salt Mine Valley site on Avery Island is a Paleo-Indian site associated with a salt-dome solution feature (CEI, 1977). The proximity of most of these relict landforms to the seafloor facilitates further investigation and data recovery.

A good faith effort was made to identify any impacts to known prehistoric sites in the Western and Central GOM as a result of recent hurricane activity; however, no such information was identified. It is possible that storm activity associated with Hurricane Rita may have impacted prehistoric sites in the shallow-water zone along the relict Sabine River valley because of its proximity to the seafloor surface. Yet, it is unlikely that Hurricane Katrina would have affected any prehistoric sites because of the deep burial of the Pleistocene surface.

3.3.5. Human Resources and Land Use

3.3.5.1. Socioeconomic Analysis Area

3.3.5.1.1. Description of the Analysis Area

The MMS defines the analysis area for potential impacts on population, labor, and employment as that portion of the GOM coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. In this description of the socioeconomic environment, sets of counties (and parishes in Louisiana) have been grouped on the basis of intercounty commuting patterns. The LMA's identified by this grouping are commuting zones, as identified by Tolbert and Sizer (1996). In their research, Tolbert and Sizer (1996) used journey-to-work data from the 1990 census to construct matrices of commuting flows from county to county. A statistical procedure known as hierarchical cluster analysis was employed to identify counties that were strongly linked by commuting flows. The researchers identified 741 of these commuting zones for the U.S. Twenty-three of these LMA areas span the Gulf Coast, from the southern tip of Texas to Miami and the Florida Keys, and comprise the 13 MMS-defined EIA's for the Gulf. **Table 3-17** lists the counties and parishes that comprise the LMA's and EIA's. **Figure 3-12** illustrates the counties and parishes that comprise the EIA's.

The LMA's adjacent to the WPA are all within Texas and include Brownsville, Corpus Christi, Victoria, Brazoria, Houston-Galveston, and Beaumont-Port Arthur. The LMA's adjacent to the CPA include Lake Charles, Lafayette, Baton Rouge, Houma, and New Orleans, Louisiana; Biloxi-Gulfport, Mississippi; and Mobile, Alabama. The LMA's adjacent to the EPA are all within Florida and include Pensacola, Panama City, Tallahassee, Lake City, Gainesville, Ocala, Tampa-St. Petersburg, Sarasota, Ft. Myers, and Miami. Use of the LMA geography brings together not only counties immediately adjacent to the GOM, but also counties tied to coastal counties as parts of functional economic areas. An analysis that encompasses where people live as well as where they work permits a more meaningful assessment of the impact of offshore oil and gas activities.

3.3.5.1.2. Land Use

The primary region of geographic influence of the proposed actions is coastal Texas and Louisiana, with a lesser influence on coastal Mississippi and Alabama. Few offshore oil and gas activities occur in the Florida area. The coastal zone of the northern GOM is not a physically, culturally, or economically homogenous unit (Gramling, 1984). The counties and parishes along the coasts of Texas, Louisiana, Mississippi, and Alabama represent some of the most valuable coastline in the U.S. Not only does it include miles of recreational beaches and the protection of an extended system of barrier islands, but it also has deepwater ports, oil and gas support industries, manufacturing, farming, ranching, and hundreds of thousands of acres of wetlands and protected habitat. These counties and parishes vary in their histories and in the composition and economic activities of their respective local governments.

Figures 3-13 through 3-15 illustrate the analysis area's key infrastructure. Major cities in the analysis area include Houston, Texas; Baton Rouge and New Orleans, Louisiana; and Mobile, Alabama. Other important cities in the analysis area include Corpus Christi, Galveston, Port Arthur, and Beaumont, Texas; Lake Charles and Lafayette, Louisiana; and Pascagoula, Mississippi. Several international and regional airports are located throughout the analysis area. One major interstate (I-10) traverses the area along the inner margin of the coastal zone, while six interstate highways access the area longitudinally. There are numerous highways into and across the analysis area. On November 28, 1995, Louisiana Highway 1 (LA Hwy 1) was designated as part of the National Highway System (NHS). The NHS Act designated 160,955 mi of interstate, highways, and other roads that are critical for the economy, defense, and mobility of the Nation as the NHS. "These highways provide access to major ports, airports, rail stations, public transit facilities, and border crossings. They comprise only 4 percent of total highways in the country; however, they carry nearly 50 percent of total highway traffic including the majority of commercial and tourism traffic. They are estimated to service more than 90 percent of businesses and industries throughout the nation" (LA Hwy 1 Project Task Force, 1999). LA Hwy 1 was designated because of "its intermodal link to this Nation's energy supply" (LA Hwy 1 Project Task Force, 1999). The area's railroad configuration is similar to the highway system. An extensive maritime industry exists in the analysis area. Major ports and waterways are discussed in detail in **Chapter 3.3.5.6**, while **Chapter 3.3.5.8** describes OCS-related coastal infrastructure. A listing of major public, recreational, and conservation areas are presented in **Chapter 3.3.3**.

The Gulf coastal plain of Texas makes up most of eastern and southern Texas and constitutes more than one-third of the State. Near the coast this region is mostly flat and low-lying. It rises gradually to 300 m (1,000 ft) farther inland, where the land becomes more rolling. Belts of low hills cross the Gulf coastal plain in many areas. In the higher areas the stream valleys are deeper and sharper than those along the coast. Texas' coastline along the GOM is 367 mi (591 km). However, long narrow islands called barrier islands extend along the coast; if the shoreline of all the islands and bays is taken into account, the coastline is 3,359 mi (5,406 km) long. The region is made up of farmland (cotton, rice, and citrus fruit), forest, cattle ranches, major cities of commerce (e.g., Houston) and education, tourist locales (e.g., South Padre Island), Federal installations (e.g., Lyndon B. Johnson Space Center), and major ports. The oil and gas industry has also been part of the local economies since the early 1900's. Today, the majority of oil and gas corporations have headquarters in Houston, while numerous industries associated with oil and gas (petrochemicals and the manufacture of equipment) are located in the area. In addition to oil and gas, the area has aggressively pursued technology companies such as computers and aerospace. The military has had a significant presence in general, particularly in the Corpus Christi Bay area, and more recently in San Patricio County on the eastern shore of the bay.

The Louisiana coastal area includes broad expanses of coastal marshes and swamps interspersed with ridges of higher well-drained land along the courses of modern and extinct river systems. Most of the urban centers in coastal Louisiana are located along major navigable rivers and along the landward edge of the coastal zone (i.e., Lafayette and Lake Charles). Southwestern Louisiana is Acadian country. The area's natural features vary from marshland, waterways, and bayous in the coastal areas to flat agricultural lands in the northern part of the same parishes. While the area's traditionally strong ties to agriculture, fishing, and trapping are still evident, they are no longer the mainstay of the economy. Southeastern Louisiana, from Jefferson Parish east to St. Tammany Parish and the State border with Mississippi, is a thriving metropolitan area with shipping, navigation, U.S. Navy facilities, and oil and chemical refineries, all vying with local residents for land. Historically, Terrebonne, Plaquemines and Lafourche Parishes have been the primary staging and support area for offshore oil and gas exploration and development. The Port of Fourchon, at the mouth of Bayou Lafourche on the GOM, is a major onshore staging area for OCS oil and gas activities in the WPA and CPA, and is the headquarters of LOOP. **Chapter 3.3.5.2** above discusses the Port Fourchon area in detail.

Coastal Mississippi is characterized by bays, deltas, marshland, and waterways. Two-thirds of this coast is devoted to State-chartered gambling barges and heavy tourism along the beachfront. The remaining third (Jackson County) is industrial—oil refining and shipbuilding. Upland portions of the three coastal counties—Hancock, Harrison, and Jackson—are timberlands. Jackson County has a strong industrial base and designated industrial parks. Pascagoula, in Jackson County, is home to Ingalls Shipyard and Chevron's Pascagoula Refinery. Bayou Casotte, also in Jackson County, currently has boat and helicopter facilities, and the onshore support base for drilling and production.

Southwestern Alabama's coastline is comprised of Mobile and Baldwin Counties, which oppose each other across Mobile Bay. Coastal resource-dependent industries in this area include navigation, tourism, marine recreation, commercial fishing, and most recently, offshore natural gas development and production. Large quantities of natural gas were discovered in Alabama's offshore waters in 1979. Baldwin County has a strong tourism economy and a large retiree population. The important commercial fishing industry in the area is located in southeastern Mobile County. The Port of Mobile, the largest seaport in Alabama, is also in Mobile County. The military has had a long presence in the area. The buildup and downsizing of military installations has handed the area some special challenges. There are several oil- and gas-related businesses, including Mobil's MaryAnn/823 plant, established in 1990, and Shell's Yellowhammer plant, founded in 1989; both of these plants process natural gas (Harris InfoSource, 1998).

The U.S. Department of Agriculture's Economic Research Service (ERS) classifies counties into economic types that indicate primary land-use patterns (U.S. Dept. of Agriculture, ERS, 2004). Most notably, only 5 of the 132 counties in the analysis area are classified by ERS as farming dependent. Nine counties are defined as mining dependent, suggesting the importance of oil and gas development to these local economies. Manufacturing dependence is noted for another 27 of the counties. Local school districts and public facilities, such as hospitals and prisons, are often the largest employers in sparsely populated rural areas. Thus, it is not surprising that 16 rural counties and 14 metropolitan counties are classified as government employment centers. Another 21 of the counties have economies tied to service employment. The ERS also classifies counties in terms of their status as a retirement destination; 39 of the 132 counties are considered major retirement destinations and 7 of the rural counties are classified as recreation dependent. The varied land-use patterns are displayed in **Figure 3-16**.

3.3.5.2. How OCS Development Has Affected the Analysis Area

The following section presents a brief, general narrative of how OCS development has affected the analysis area over the last 25 years. This narrative is followed by a specific account of how OCS development has affected certain locales in the analysis area.

A recent study sponsored by MMS (Pulsipher, 2006) analyzes the socioeconomic impacts of the offshore oil and gas industry on Louisiana's coastal parishes. Specifically, growth in per capita personal income in 19 coastal parishes in Louisiana is compared with 45 noncoastal parishes over the 1969-2000 time period. The time period is divided into the 1969-1980 domestic "energy boom," the 1980-1985 "price erosion and collapse," the 1986-1990 "recovery," and the 1991-2000 "energy lull." Per capita personal income is divided into the components accounting for its rate of growth; improvements in industry mix, changes in relative wages, participation in the labor force, receipt of transfer payments, and property income for each of the four phases. The approach is a way to compare systematically the economic experience of the residents of coastal parishes with the experience of those further removed but still affected by the same changes in the regional and national economies. Comparisons using this same approach are also made of the five states bordering the GOM and of Louisiana's eight metropolitan areas to provide context.

The study found that offshore production mitigated or had an opposing (positive) effect compared with onshore production. It was a source of stability and growth for coastal communities. It gave them partial relief from the economic consequences of nose-diving onshore production during the collapse period. However, this result should not be confused with the cumulative effects of the offshore oil and gas industry. Looking at the experience of the coastal parishes of Louisiana and the five Gulf Coast States leads to a similar conclusion: although differential effects are evident during the collapse period, no lasting, cumulative effects from offshore oil and gas production – either positive or negative – are evident in the study results.

1980-1989

In the oil and gas industry, drilling-rig use is employed as a barometer of economic activity. Between the end of 1981 and mid-1983, drilling-rig activity in the GOM took a sharp downturn. By 1986, the demand for mobile drilling rigs had suffered an even greater decline because of a collapse in oil prices. Population and net migration paralleled these fluctuations in mobile drilling rig activity. Population growth rates for all EIA's were relatively high prior to 1983. During these years, much of the U.S. was experiencing an economic recession and families moved to the Gulf Coast looking for work in the booming oil and gas industry. After 1983, lower rates of population growth accompanied the decline in drilling activity as workers were laid off and left the area in search of work elsewhere and all EIA's experienced several years of significant net migration out of the region. In 1986 the demand for mobile rigs declined to its lowest level in over a decade. This negative trend on population continued through the late 1980's (Maruggi and Saussy, 1985; Maruggi and Wartenberg, 1996).

1990-1999

In the early to mid-1990's, the analysis area experienced a major resurgence in oil exploration and drilling in response to advances in technology and the enactment of the Deep Water Royalty Relief Act in 1995. The renewed interest in oil and gas exploration and development in the GOM produced a modest to significant recovery from the high unemployment levels experienced after the 1986 downturn. Ironically, the Gulf Coast encountered a shortage of skilled labor in the oil and gas industry as the oil industry restructured to centralize management, finance, and business services, and new generation computer technologies were applied during the downturn (Baxter, 1990). Workers who previously lost high-paying jobs in the oil industry (or oil-service industry) during the 1980's downturn were reluctant to return. This "shadow effect," coupled with the shortage of skilled labor where the core problems were lack of education and/or training for requisite skills, created a situation where temporary communities of workers from out of the area (some from out of the country) were established (Donato, 2004). Furthermore, the higher skill levels required by deepwater development drilling could not be completely met by the existing impact areas' labor force, causing in-migration. Unemployment in the analysis area, though, declined due to increased economic diversification in the region.

In early 1998, crude oil prices were hovering near 12-year lows due in part to economic developments in East Asia and resulting oversupply of oil (USDOE, EIA, 2001a). This restrained the resurgence of exploration and development activity in the GOM. While offshore development strategy varied by company, most major oil companies, diversified firms, and small independents cut back production and curtailed exploration projects. Several large integrated companies resorted to layoffs and mergers as ways to show profitability in a low-price environment. Redistribution of industry personnel from the New Orleans area to the Houston area also occurred. Unemployment in the analysis area rose. Offshore drilling strategies focused on mega and large prospects, foregoing small prospects, and only considering medium prospects when prices rose (Rike, 2000). A few companies, though, took advantage of lower drilling rates during this period and increased their drilling. Concurrently, technological innovations (such as the availability of 3-D seismic data, slim-hole drilling, and hydraulic rigs) decreased the cost of exploration and thus stimulated the discovery and development of large or mega prospects that were previously considered uneconomic at low prices. In March 1999, OPEC, which produced 40 percent of the world's oil, announced crude oil production cutbacks. Full member compliance increased oil prices to 20-year highs, encouraging moderate exploration and development spending in 1999.

2000-Present

After the OPEC announcement in 1999, crude oil prices continued to increase during 2000 and into 2001. It is generally believed that the increase in price was driven by two major factors. First was the determination by OPEC to maintain prices within their current output targets of a $22 minimum and a $28 maximum per barrel crude oil price. The second factor was the world capacity to supply oil had not kept pace with the growth of oil demand spurred by a resurgent world economy. Furthermore, a short supply of oil tankers, rising shipping rates, and low inventories of refined product and crude oil have added upward pressure to spot crude oil prices (Brown, 2000). The prices throughout much of the 1990's had been too low to stimulate additions to capacity and in addition, many tankers had been scrapped in the 1990's when weak demand, low shipping rates, and increasing environmental regulation put a lot of pressure on the tanker industry (Brown, 2000).

Federal environmental/clean-air efforts in the 1990's and high oil prices in the late 1990's prompted some industries to switch from crude oil to natural gas. This development was, and continues to be, especially prevalent in the electricity generating industry. Natural gas, in addition to heating about 53 percent of American homes, is also being used to generate about 16 percent of the country's electricity — a percentage that is still growing (Simmons, 2001). Like crude oil, the supply of natural gas did not keep up with demand, which pushed prices higher. In December 2000, the price of natural gas broke record highs, closing at $10.10 per 1,000 cubic feet. In the months that followed, however, natural gas prices decreased as much as 75 percent. Several factors kept a downward pressure on natural gas prices in 2002. These factors include moderate weather in most of the Nation, which kept the demand for gas by electricity generators in check; relatively low oil prices; and a general economic slowdown that began in 2001, which reduced demand for gas by the industrial sector (FERC, 2001). Even without this pronounced drop in price, demand growth for natural gas is expected to be strong during the next 20 years. The 2001 *Update of the Fueling the Future: Natural Gas and New Technologies for a Cleaner 21st Century* report projects that natural gas demand would increase by 53 percent by the year 2020 (American Gas Foundation, 2001).

Further technological advances and the passage of the Deep Water Royalty Relief Act in 1995 stimulated deepwater leasing and subsequent exploration and development activities. Needs specific to these deepwater projects have resulted in more focused stresses placed on areas that are capable of supporting large-scale development projects (e.g., ports that can handle deeper draft service vessels such as Port Fourchon, Louisiana). This, in turn, has resulted in stresses to infrastructure servicing these focal points (particularly highways and ports), as well as placing stresses on the infrastructure associated with the focal point.

Port Fourchon, Louisiana, has become one of these important focal points. It is located at the mouth of Bayou Lafourche, is one of the main service-supply bases for offshore oil and gas exploration and development in the GOM. While the port has maintained steady growth over the last 25 years, the escalation of deepwater activities has produced rapid growth at the port in the last 5 years, as the port has become one of the OCS Program's focal points. Port Fourchon's tenants are equipped to accommodate a comprehensive range of offshore support services, including offshore supply and support, anchor handling, towing, offshore construction, sales, and barging of fuel, water, mud, completion fluids, barites and methanol, riser inspection and repair, logistics, vessel repairs, rig inspection and repair, pipe storage, repair and bucking, complete dockside and in-slip loading, helicopter base operations, heavy-lift capabilities, and trucking (Paganie, 2006a). More than 250 vessels a day travel the port's channels.

In addition to more than 130 OCS oil- and gas-related businesses, the Louisiana Offshore Oil Port (LOOP) facilities are located at the port. The LOOP is the only offshore oil terminal in the U.S.; on average, LOOP handled about 1.2 MMbbl/d of imported oil in 2005 – approximately 14 percent of the Nation's imported waterborne crude oil (Paganie, 2006c; Randolph, 2006; Boulet, 2006a). The LOOP also handles about 300,000 bbl per day of domestic offshore crude oil and is expected to increase this capacity. Louisiana Highway 1 (LA Hwy 1) is a vital link to LOOP's Fourchon Booster Pump Station and to LOOP's Harbor at Port Fourchon, which is a support and staging area for LOOP's offshore facilities (Randolph, 2006; Boulet, 2006a).

In 1996, Edison Chouest Offshore (Chouest) built its highly successful C-Port at Port Fourchon. The C-Port is a multiservices port terminal facility supplying offshore vessels that operate in the GOM. The C-Port can load/offload deck cargoes, fuel, water, cements, barite muds, liquid muds, and completion fuels simultaneously. These services are provided under the protection of a covered building, eliminating weather and darkness, while improving safety and efficiency, making it a highly cost-effective, cost-saving solution (Edison Chouest Offshore, 2001). Prior to C-Port, it took 1-2 days to service a vessel; today, service time is down to a few hours. This results in huge dollar savings for offshore companies. In addition, the companies need to lease fewer service boats because of the larger, technologically advanced ships that Chouest is building. In 1999, Chouest completed a second C-Port at Port Fourchon, C-Port 2. Together, C-Port and C-Port 2 are servicing approximately 90 percent of OCS deepwater activity. In addition to the port expansion, Chouest began an aggressive "new build" program in the late 1990's for their offshore service vessels. The company has produced over 50 new generation offshore vessels to serve deepwater oil and gas production. The new vessels are larger (260 ft in length) and faster than their predecessors servicing shallow-water activities. The C-Ports and the new deepwater service vessels have increased activity at Port Fourchon greatly.

Based on OCS activity at the port, the Corps of Engineers (COE) justified deepening Port Fourchon's channel from 12 to 24 ft. The port had been maintaining the channel at 20 ft for the larger OCS supply vessels. In August 2001, the COE dredged the channel to a depth of 26 ft (24 ft plus 2 ft of advance maintenance). As part of its strategic plan for the future, the port is planning a new 50-ft channel (Falgout, 2006b).

To date, this focusing of offshore service activities at Port Fourchon has resulted in both positive and negative impacts on the area. Lafourche Parish, where the port is located, has one of the lowest unemployment rates in the nation, but in some ways its citizens' quality of life has decreased. Increased OCS activity is straining the local infrastructure, including a substandard highway that is not able to handle the truck traffic increase from increased OCS activities.LA Hwy 1, largely a rural substandard two-lane road, is the only land-based transportation route to the port. Results from an MMS-funded study on the infrastructural impacts of expanding OCS oil and gas activities in south Lafourche Parish*, An Analysis of Louisiana Highway 1 in Relation to Expanding Oil and Gas Activities in the Central GOM*, indicate that the levels of service provided by LA Hwy 1 will decline significantly through time (Guo et al., 2001). The study estimated a 3-6 percent growth in daily vehicle traffic along LA Hwy 1. Actual 2000 growth was 24 percent; more than 1,000 OCS supply and equipment trucks travel LA Hwy 1 to the port each day. Since the 2005 hurricane season, the demand upon the Port to provide critical OCS related services has increased dramatically, resulting in double digit traffic increases on LA Hwy 1 and an increase in daily truck traffic to about 1,300 (Falgout, 2006b). January and February 2006 traffic counts have averaged nearly 20 percent above last year for those months, further impacting an already stressed system (Falgout, 2006a). In addition to servicing the OCS, LA Hwy 1 serves as a hurricane evacuation route for a local population of 35,000 residents and over 6,000 offshore workers, as well as an oil-spill response route for offshore spills (Paganie, 2006b). The Louisiana Oil Spill Coordinator has identified LA Hwy 1 as the most critical highway for oil-spill response in the state (Randolph, 2006). Offshore companies also take valuable equipment, such as bagged drilling fluids, off offshore rigs and bring it to safety inland. This increases the truck traffic along LA Hwy 1 during the evacuation process. The number of fatalities on LA Hwy 1 has increased directly with the growth of the OCS and, therefore, of truck traffic to and from the port. Furthermore, statistics from the Louisiana Department of Transportation and Development (DOTD) reveal LA Hwy 1 as twice as likely to have a crash and having a higher percentage of fatalities compared to the statewide average on similar designated state highways (Boulet, 2006c). There is no access control along LA Hwy 1, and almost all properties along the roadway have direct access to this roadway and often have multiple driveways on the LA Hwy 1. The majority of the LA Hwy 1 facility is an undivided roadway with substandard horizontal curvature throughout much of the corridor. This roadway has limited or no shoulders in many locations resulting in vehicle accidents blocking travel lanes and creating congestion and delay as well as safety concerns (Boulet, 2006c).

The south Lafourche Parish study concluded that deterioration of LA Hwy 1 will be exacerbated with expanding oil and gas activities, particularly those in deep water. The size and complexity of these deepwater projects, along with the limited number of service bases capable of handling their unique needs, and the addition of the C-Ports at Port Fourchon, will likely result in continued stresses on port infrastructure and associated stresses placed on the local infrastructure, especially LA Hwy 1 and the parish's water supply (Guo et al., 2001).

Exacerbating the traffic problems on LA Hwy 1 are delays caused by the six bridge openings necessary to accommodate barge traffic on Bayou Lafourche. Roughly 50 percent of all oil and gas materials brought to Port Fourchon is barged. On average, each bridge is opened 16 times a day resulting in bottlenecks, increased accidents, and a lower quality of life. In May 2006, work began on a multiyear \$160 million project to build a bridge to replace the Leeville lift bridge (Russell, 2006; Boulet, 2006a). Recent inspections by the Louisiana DOTD had identified it as the second most scoured bridge in the State, with a sufficiency rating of 44 out of 100 and a structural rating of 5 out of 10 (Boulet, 2006b). Deepwater expansion has significantly increased the demand for water, taxing the local freshwater district. Since 1998, the water usage by the port customers has gone from 1.4 million gallons per day to over 2 million gallons per day in 2006 – straining the Water District's infrastructure and finances (Barrios, 2006). Water usage has continued to increase since the 2005 hurricane season because of the increased activity at Port Fourchon.

The demand for OCS-related labor in the area has resulted in in-migration from the temporary importation of labor, particularly in south Lafourche. This unique situation has been exacerbated by the shadow effect. The unusual work schedules in the oil and gas extraction industry also supports employment outside the analysis area because long-distance commuting can be reasonably accomplished on such an infrequent basis. Thus, while employment opportunities are growing in the oil and gas extraction and supporting industries within the GOM analysis area, some of that employment has been met from outside the area. This has resulted in net positive migration in some focal point locales and has caused a scarcity of housing, a shortage of municipal personnel (i.e., policemen, firemen, engineers, etc.), stresses on the capabilities of available infrastructure, and an increase in the cost of living. Chouest, which owns C-Port and C-Port 2 in Port Fourchon, North American Shipbuilding in Larose, Louisiana, and North American Fabricators in Houma, Louisiana, have experienced these impacts first hand. Unable to find housing for their workers, Chouest built an apartment complex for the workers they had to recruit from outside of Louisiana because of the labor and skills shortage within the State.

The extensive deterioration of LA Hwy 1 is mostly due to subsidence and coastal landloss from wave forces; LA Hwy 1 divides the Barataria and Terrebonne estuaries, the Nation's two most productive estuaries. Port Fourchon has been active in building up the embankment with channel dredging materials, but it is a short-term fix to a long-term problem that grows worse every day. At present, Golden Meadow, Louisiana, to Larose, Louisiana, is the only section of the highway that is four lanes.

In past multisale EIS's, MMS recognized the importance of Port Fourchon and LA Hwy 1 to the Nation's energy infrastructure and emphasized the area's desire for impact assistance to ameliorate effects of the OCS Program. As the port has grown, its importance to the Nation's energy infrastructure has increased significantly. Twenty percent of the Nation's oil and 25-27 percent of the natural gas are located offshore Louisiana. The port services more than 75 percent of the Gulf's deepwater production. In addition, Port Fourchon is currently servicing over half of the drilling rigs working in the GOM OCS, and it is projected that the facility will service 60 percent of all drilling in the central Gulf over the next 30 years (Paganie, 2006a). Furthermore, around 650 MMbbl of crude is transported via pipelines through the base each year, its facilities handle 13-15 percent of the Nation's imported oil, and the major pipelines running through the port connect to over half of the U.S. refining capacity (Paganie, 2006a). With the increasing importance of deepwater development and the potential for FPSO's working in the GOM in the near future, LOOP will become even more important to the U.S. energy intermodal system and, therefore, so will Port Fourchon. In addition, demand for port facilities has risen even more since Hurricanes Katrina and Rita as companies repair rigs, wells, and pipelines. Port Fourchon took a relatively small blow from both hurricanes, but ports in Venice and Cameron were severely damaged and are still recovering. Within a week of Hurricane Katrina, Port Fourchon was approaching 35-45 percent of pre-Katrina activity, and in a month it was 90 percent (Russell, 2006). Hurricane Rita stopped all activity, but again it took only days to get the port back up and running.

LA Hwy 1 has also been recognized on the national level. In 1995 LA Hwy 1 was selected as part of the National Highway System (NHS) because of its intermodal link to this Nation's energy supply. The NHS Act designates roads that are critical for the economy, defense, and mobility of the Nation. In December 2001, Congress designated LA Hwy 1 as one of only 44 high-priority corridors in the U.S. based on its significance to the Nation's energy infrastructure. About 1,000 trucks enter and leave Port Fourchon via LA Hwy 1 each day, and traffic is expected to increase by 60 percent by 2010 and by 80 percent over the next decade, further accentuating the need for major highway improvements (Russell, 2006; Paganie, 2006a). To improve this most crucial, yet weak link, the Louisiana DOTD is constructing a 17-mi elevated, four-lane highway from Golden Meadow, Louisiana, to Port Fourchon. The new highway is expected to open in December 2009 (Boulet, 2006a). The ultimate goal of the LA1 Coalition, however, is to replace the entire 47 mi from U.S. 90 to Grand Isle with a four-lane highway elevated below Golden Meadow, with a projected cost of $1.5 billion. Other recent plans for expansion at Port Fourchon include the development of a 700-ac site that will more than double the size of the port, the construction of a major drilling rig repair facility; dredging a 50-ft channel to extend 6.5 mi into open waters, and improvements to expand the airfield's runway (Paganie, 2006a).

Several other service bases have also seen a large increase in OCS-related activity and concomitant stresses placed on their local infrastructure. These ports include Cameron, Venice, and Morgan City, Louisiana. The limited number of service bases capable of servicing deepwater activities suggests that stresses placed on local infrastructure at these bases will continue to the extent that deepwater tracts are leased, explored, and developed. Recent leasing history has shown an increase in deepwater interest.

The fast pace of deepwater drilling is approaching record levels. As of June 2006, 15 companies are drilling 33 wells in water depths greater than 1,000 ft. In 2005, 119 deepwater wells were drilled and the total number of exploratory wells spudded in deepwater since 1995 is close to 1,000. By March 2006, 118 production projects were ongoing in deepwater GOM waters and nearly one-third of the world's total deepwater drilling fleet was committed to programs there (Baethe, 2006).

As more activity continues to move farther offshore, the requirements of the onshore support network become more challenging. Vessels used to service deepwater activities require more draft and only a few ports have this type of access. Many onshore companies have migrated to areas that are capable of handling these deepwater vessels. Deepwater drilling also requires the assistance of helicopters. The intermodal nature of the needs of deepwater drilling makes ports an ideal location and a vital factor in the sustainability of offshore activities.

Distribution of Federal Offshore Revenues to States

Revenues from Federal onshore and offshore mineral leases are one of the largest sources of nontax income. The MMS distributes revenues collected from Federal mineral leases to special-purpose funds administered by Federal agencies, to States, and to the General Fund of the U.S. Department of the Treasury. Legislation and regulations provide formulas for the disbursement of these revenues.

Section 8(g)

Section 8(g) of the Outer Continental Shelf Lands Act (OCSLA) Amendments of 1978 provided that the States were to receive a "fair and equitable" division of revenues generated from the leasing of lands within 3 mi (5 km) of the seaward boundary of a coastal State containing one or more oil and gas pools or fields underlying both the OCS and lands subject to the jurisdiction of the State. The States and the Federal Government, however, could not reach agreement concerning the meaning of the term "fair and equitable." Revenues generated within the 3-mi 8(g) boundary were placed into an escrow fund beginning August 1979.

Congress resolved the dispute over the meaning of "fair and equitable" in the OCSLA Amendments of 1985 (P.L. 99-272). The law provides for the following distribution of Section 8(g) revenues to the States:

- disbursement of escrow funds during FY 1986-1987;
- a series of annual settlement payments disbursed to the States over a 15-year period from FY 1987 to FY 2001; and
- recurring annual disbursements of 27 percent of royalty, rent, and bonus revenues received within each affected State's 8(g) zone.

The table below shows the disbursement of Federal offshore 8(g) revenues by Gulf Coast State for fiscal years 1986 through 2005.

Federal Offshore 8(g) Revenues by Gulf Coast State
($ millions)

State	FY 1986-2002	FY 2003	FY 2004	FY 2005
Alabama	$185.76	$13.20	$13.71	$14.62
Florida	$2.42	$0.00	$0.00	$0.00
Louisiana	$939.70	$29.56	$38.26	$30.90
Mississippi	$21.02	$0.43	$0.52	$1.02
Texas	$736.66	$14.93	$13.25	$10.42

Source: USDOI, MMS, 2006b.

The Land and Water Conservation Fund (LWCF)

The Land and Water Conservation Act of 1965 created the LWCF, which is administered by the National Park Service. It provides revenues for the Federal Government, State governments, and local governments to purchase parks and recreation areas and to plan, acquire, and develop land and water resources for recreational use, habitat protection, scenic beauty, and biological diversity. During the past decade, about 90 percent of the $900 million that the LWCF receives every year is from revenues generated from offshore oil and gas activities. In FY 2005, MMS disbursed $898,869,789 to the LWCF (USDOI, MMS, 2006b).

National Historic Preservation Fund (NHPF)

The NHPF is administered by the National Park Service and is designed to expand and accelerate historic preservation plans and activities. The fund provides revenues for matching grants-in-aid to States and local governments, and funds the National Trust for Historic Preservation. Offshore mineral leasing receipts provide 100 percent of the $150 million transferred to the Fund annually. In FY 2005, MMS disbursed $150,000,000 to the NHPF (USDOI, MMS, 2006b).

Coastal Impact Assistance Program

The Energy Policy Act of 2005 (Public Law 109-58) was enacted on August 8, 2005. Section 384 of the Act establishes the Coastal Impact Assistance Program (CIAP) which authorizes funds to be distributed to OCS oil and gas producing states to mitigate the impacts of OCS oil and gas activities.

Under the CIAP, the Secretary of the Interior is authorized to distribute to producing States and coastal political subdivisions $250 million for each of the fiscal years 2007 through 2010. This money will be shared among Alabama, Alaska, California, Louisiana, Mississippi, and Texas and will be allocated to each producing State and eligible coastal subdivision based upon allocation formulas prescribed by the Act. Pursuant to the Act, a producing State or coastal political subdivision shall use all amounts received under this section for one or more of the following purposes:

- projects and activities for the conservation, protection, or restoration of coastal areas, including wetlands;
- mitigation of damage to fish, wildlife, or natural resources;
- planning assistance and the administrative costs of complying with this section;
- implementation of a federally-approved marine, coastal, or comprehensive conservation management plan; and
- mitigation of the impact of OCS activities through funding or onshore infrastructure projects and public service needs.

The CIAP fund's allocations will be known in late spring FY 2007. States will first have to submit a coastal impact assistance plan, which the Secretary must approve before funds can be disbursed. This plan must be submitted no later than July 1, 2008.

3.3.5.3. Current Oil and Gas Economic Baseline Data

Oil and natural gas prices are used to evaluate the oil and gas industry's ability to economically develop resources. Prior to Hurricane Katrina, the average U.S. retail gasoline price had increased 40 percent year-on-year to $2.58 per gallon. Immediately after Hurricane Katrina, that price peaked at $3.04 per gallon, an increase of 17 percent in one week (Simmons & Company International, 2005). Natural gas prices had also been high prior to Hurricane Katrina. In the weeks before Hurricane Katrina made landfall, natural gas spot prices were climbing to $10 per MMBtu. Prices had increased more from 10 to 17 percent at most market locations in the Northeast and GOM (USDOE, EIA, 2005a). As of August 17, 2005, natural gas prices at most market locations were about 60-90 percent 2004 levels (USDOE, EIA, 2005a). Immediately after Hurricane Katrina hit, the already elevated natural gas prices went still higher. Spot trading on the Henry Hub was suspended for a day because of a shut-in of the hub. For the week after landfall, spot gas at Henry Hub was up to $12.70, the highest price recorded at the hub since February 2003. The price shocks from the loss of Gulf supplies rippled through the U.S. (USDOE, EIA, 2005b).

Current oil and natural gas prices are above the economically viable threshold for drilling in the GOM. As of June 30, 2006, West Texas Intermediate was priced at $73.93/bbl and Henry Hub natural gas was priced at $5.810/MMBtu in the U.S. spot market (Oilnergy, 2006). The NYMEX contract for benchmark U.S. light, sweet crude was $73.52/bbl for August delivery and $74.51/bbl for September delivery (Oil and Gas Journal Online, 2006). Energy prices continued to climb during the end of June as front-month gasoline futures hit the highest price level in the New York Market since Hurricane Rita. Geopolitical tensions in Iran, Iraq, and Nigeria have been among the main drivers behind the price increases this year.

Drilling rig use is employed by the industry as another barometer of economic activity. Marketed utilization rates (based on marketed supply) in the GOM hovered around 90 percent or higher for most of 2000 through May 2001, before beginning a downward spiral to a low of nearly 50 percent in November 2001. Over the last year rig utilization rates were back up to just under 90 percent and have remained stable, 86.3 percent in June 2005 and 88.5 percent in June 2006 (Rigzone, 2006). It should be noted that the effective utilization rate was essentially 100 percent, since the surplus rigs are not immediately ready and available for work. As utilization rates have escalated so too have average day rates. The average jack-up day rate in the GOM for April was $127,103 and for May was $132,900 (One Offshore, 2006a; 20:33). The average day rate trend for semisubmersibles in the GOM remains on an inclined path even though average day rates hit a peak of $376,990 in March before falling slightly to $343,827 for both April and May (One Offshore, 2006a; 20:33). More upward pressure on GOM day rates seems likely, as a number of rigs will leave the area for long-term commitments in other markets.

As rig day rates hover at record highs, rig demand has been increasing worldwide. In 2005, 8 rigs were delivered, for 2006, 12 rigs are scheduled to be delivered (One Offshore, 2006b; 20:35). In the GOM, rig demand has been increasing at the same time that supply has been decreasing. Average May 2006 utilization was its highest level in years. Utilization rates were on the rise until August 2005, just prior to the devastating 2005 hurricane season that caused damage to several rigs and led part of the decrease in supply (One Offshore, 2006b; 20:35). The increasing number of rigs under construction and scheduled for delivery is insufficient to meet operators' growing demand for contract drilling services worldwide, so the tight U.S. Gulf rig supply situation will continue.

Heightened activity in the offshore rig market has also meant a boom for offshore service vessels (OSV). At the end of 2005, with the exception of a handful of vessels at shipyards, every active OSV in the GOM was working. Every vessel owner surveyed indicated that they could immediately put additional vessels to work if any were available (One Offshore, 2005a; 20:11). Day rates are reflecting the tight supply and heavy demand and some vessel owners feel that they can even name their price in certain situations. The April 2006 average day rates were as follows: anchor-handling tug/supply (AHTS) vessel ranges from $12,500 for under 6,000-hp vessels to $70,000 for over 6,000-hp vessels; supply boat ranges from $12,500 for boats up to 200 ft and $19,000 for boats 200 ft and over; and crewboats range from $4,800 for boats under 125 ft to $7,667 for boats 125 ft and over (Greenberg, 2006a). In comparison, the April 2005 average day rates were as follows: AHTS vessel ranges from $12,500 for under 6,000-hp vessels to $24,850 for over 6,000-hp vessels; supply boat ranges from $6,025 for boats up to 200 ft and $11,515 for boats 200 ft and over; and crewboats range from $2,625 for boats under 125 ft to $4,825 for boats over 125 ft and over (Greenberg, 2006a). As of June 2006, U.S. GOM OSV owners reported that 221 vessels (i.e., every available) were under contract. Operators are seeking long-term commitments, and 1- and 2-year firm deals are becoming more common (One Offshore, 2006c; 20:37).

Another indicator of the direction of the industry is the exploration and production (E&P) expenditures of the oil and gas companies. According to the annual *Original E&P Spending Survey* by equity research analysts at Lehman Brothers, U.S. exploration and production spending will increase to $57 billion in 2006 compared with estimated 2005 expenditures of $50 billion (One Offshore, 2005b; 20:9). This represents a 14.9-percent increase in spending on the part of the 247 companies participating in the survey. However, Lehman analysts note that costs are driving budgets and that much of this spending increase is being driven by higher costs. In a reversal of the trend in recent years, most majors are budgeting higher domestic spending in 2006. Lehman analysts believe that they have recently become more attracted to unconventional gas plays and that increased competition abroad from national oil companies and limited access to some areas of the world is pushing the majors back to the United States (One Offshore, 2005b; 20:9).

Lease sales are another indicator of the offshore oil and gas industry. Sales over the last several years have resulted in a relative increase in the number of blocks leased. In addition, recent lease sales show a continued strong interest in deep water and a renewed interest in shallow water. The most recent Central GOM sale held in March 2006 attracted 82 companies submitting 707 bids totaling close to $1 billion. The highest bid accepted was for almost $43 million. Although the three highest bids were all in deep water, the sale also indicated a continued interest in shallow-water areas as 47 percent of the tracts receiving bids were in less than 200 m (656 ft) of water (USDOI, MMS, 2006c).

Lease Sale 200, which was held in August 2006, garnered close to $341 million in high bids from 62 companies. The total of all 541 bids on 381 tracts was nearly $463 million, a 38 percent increase over last year's Western Gulf sale. Interest in deepwater oil and gas production continues to grow, with 67 percent of all tracts receiving bids in water depths greater than 400 m (1,312 ft). The increased number of tracts receiving bids in shallow water indicates ongoing industry interest in deep gas in shallow waters as well.

3.3.5.4. Demographics

Offshore waters of the WPA, CPA, and EPA lie adjacent to coastal Texas, Louisiana, Mississippi, Alabama, and Florida. In this description of the socioeconomic environment, sets of counties (and parishes in Louisiana) have been grouped on the basis of intercounty commuting patterns. The LMA's identified by this grouping are commuting zones, as identified by Tolbert and Sizer (1996). Tolbert and Sizer (1996) used journey-to-work data from the 1990 Census to construct matrices of commuting flows from county to county and employed a statistical procedure known as hierarchical cluster analysis to identify counties that were strongly linked by commuting flows. The researchers identified 741 of these commuting zones for the U.S. Twenty-three of these LMA areas span the Gulf Coast, from the southern tip of Texas to Miami and the Florida Keys, and comprise the 13 MMS-defined EIA's for the Gulf. **Table 3-17** lists the counties and parishes that comprise the LMA's and EIA's. **Figure 3-12** illustrates the counties and parishes that comprise the EIA's.

The LMA's adjacent to the WPA are all within Texas and include Brownsville, Corpus Christi, Victoria, Brazoria, Houston-Galveston, and Beaumont-Port Arthur. The LMA's adjacent to the CPA include Lake Charles, Lafayette, Baton Rouge, Houma, and New Orleans, Louisiana; Biloxi-Gulfport, Mississippi; and Mobile, Alabama. The LMA's adjacent to the EPA are all within Florida and include Pensacola, Panama City, Tallahassee, Lake City, Gainesville, Ocala, Tampa-St. Petersburg, Sarasota, Ft. Myers, and Miami. Use of the LMA geography brings together counties immediately adjacent to the GOM, and also counties tied to coastal counties as parts of functional economic areas. An analysis that encompasses where people live as well as where they work permits a more meaningful assessment of the impact of offshore oil and gas activities.

3.3.5.4.1. Population

Tables 3-18 through 3-30 provide an overview of the Gulf Coast population and employment in the GOM coastal region. The area's population increased by 19 percent between 1990 and 2000 and by 9 percent between 2000 and 2006. The region's current total population is 23.3 million. In the U.S., population age structures typically reflect the presence of the baby-boom generation. This scenario is manifested in the Gulf Coast region by the relative decline in lower age cohorts over time. More distinctive is the changing race and ethnic composition of the region, which has a long-standing tradition of cultural heterogeneity (Gramling, 1994). While the African-American population increased 23.6 percent between 1990 and 2000, the growth rate has declined to 8.2 percent between 2000 and 2006. The Hispanic population increased 53.8 percent between 1990 and 2000 and has continued to increase rapidly since 2000 (24.4%). This group is now the second largest race/ethnic group in the region, making up 25.8 percent of the Gulf Coast population. Although Asians and Pacific Islanders constitute a relatively small proportion of the Gulf Coast population, this group has experienced the highest growth rate between 1990 and 2000 (82.5%) and between 2000 and 2006 (28.2%). The white population has steadily declined and currently constitutes 53.6 percent of the region's population.

Based on employment, the largest industry sectors in the Gulf Coast region are services (35.6%) and retail trade (16.6%). The most notable changes in the industry distribution have been the decreased share in manufacturing (declining from 9% in 1990 to 6% in 2006) and the increased share in services (29% in 1990 and 36% in 2006). These overall trends vary from one Gulf Coast State to another and from one LMA to another.

On August 29, 2005, Hurricane Katrina made landfall along the Gulf Coast near New Orleans, Louisiana. The storm caused catastrophic damage along the coasts of Louisiana, Mississippi, and Alabama, including a storm surge that breached the levee system protecting New Orleans and leading to widespread flooding of the city. Hurricane Katrina stands to be the costliest natural disaster in the history of the U.S. – estimates of economic losses run as high as $200 billion (Wolk, 2005) – and perhaps the greatest humanitarian crisis the Nation has experienced since the Great Depression – over 1,000 people were killed (CNN, 2005) and millions were affected (Ericson et al., 2005).

Less than 1 month later, on September 24, 2005, as the residents of the region still reeled from Hurricane Katrina, Hurricane Rita made landfall along the Gulf Coast near the Louisiana-Texas border. Though of a lesser magnitude than Katrina, Rita nonetheless, caused extensive damage throughout the region, particularly in the coastal parishes of southwestern Louisiana.

In response to the damage from the two disasters, the Federal Emergency Management Agency (FEMA) designated 433 counties and parishes spanning five states (i.e., Alabama, Florida, Louisiana, Mississippi, and Texas) as in need of Federal assistance (FEMA, 2005). FEMA designated a number of counties and parishes to receive public assistance to State and local governments and certain private nonprofit organizations, while a smaller number were designated to receive individual assistance for affected individuals and households for housing and assistance with other needs. **Figure 3-18** shows those counties and parishes affected by the storms. Following the typology used by the Bureau of Labor Statistics (BLS), an area is considered "affected" if it was designated by FEMA for any type of assistance and is considered "most affected" if it was designated for both public and individual assistance; 200 counties and parishes fit the first definition, and 100 counties and parishes fit the latter definition (U.S. Dept. of Labor, Bureau of Labor Statistics, 2005).

The Congressional Research Service (CRS) estimates that 700,000 or more people may have been directly impacted by Hurricane Katrina as a result of residing in areas that flooded or sustained significant structural damage. This estimate is based on a geographical analysis of FEMA flood and damage assessments and 2000 Census data. The analysis shows that the Louisiana parishes of Orleans and St. Bernard were especially hard hit by flooding, with an estimated 77 percent of Orleans' population affected and nearly all residents of St. Bernard affected. In Mississippi, 55 percent of Hancock County's population is estimated to have been affected by flooding and/or structural damage, and in the more populous Harrison County, about 19 percent of its population. In Louisiana, an estimated 645,000 people may have been displaced by the hurricane and 66,000 in Mississippi (based on 2000 Census data) (Gabe et al., 2005).

Hurricane Katrina had varying impacts on the population. The CRS estimates that, of the people most likely to have been displaced by the hurricane, about half lived in New Orleans. Because of the city's social and economic composition, the storm significantly impacted the poor and African-Americans. The CRS estimates that one-fifth of those displaced by the storm were likely to have been poor, and 30 percent had incomes that were below 1.5 times the poverty line. African-Americans are estimated to have accounted for approximately 44 percent of storm victims. An estimated 88,000 elderly persons (aged 65 and older), many with strong community ties, may have been displaced, along with 183,000 children, many of whom were just starting the school year when the storm struck (Gabe et al., 2005). An estimated 4,500 American Indians living along the southeast Louisiana coast lost everything to Hurricane Katrina, according to State officials and tribal leaders. Officials estimate that 5,000-6,000 American Indians lost their homes or possessions because of Hurricane Rita. The Louisiana tribes most affected by the two hurricanes are the United Houma Nation, the Pointe-au-Chien Tribe, the Isle de Jean Charles Indian band of Biloxi-Chitimasha, the Grand Caillou-Dulac Band, and the Biloxi-Chitimasha Confederation of Muskogees (Democracy Now, 2005).

Between December 2005 and February 2006, estimates show that the city of New Orleans and the New Orleans metropolitan region experienced a measurable increase in its population. These include returnees as well as new migrants employed in the region (Katz et al., 2006). The City of New Orleans' population survey of residential structures estimates that there were approximately 181,400 residents living in the city in January 2006, far lower than its pre-Katrina population of 484,674 (Stone et al., 2006). The daytime population is significantly higher because of the influx of visitors and workers in the city. Although this population survey best reflects current conditions and provides reliable overnight and daytime population estimates, the methodology used is likely to underestimate the city's current population (Stone et al., 2006). The information from this survey is not intended to be an official census of the city. Updated city and parish population estimates for New Orleans are expected in the fall 2006.

In addition to the population statistics for the City of New Orleans, current data also show that the New Orleans metropolitan area population is currently 18 percent lower than before Hurricane Katrina made landfall. The pre-hurricane population estimate for the region was 1,292,774 and the current estimate is 1,065,000. Current population estimates show declines in Orleans Parish (46%), St. Bernard Parish (71%), and Plaquemines Parish (22%). However, Jefferson Parish (0.3%), St. Tammany Parish (8%), St. Charles Parish (10%), and St. John the Baptist Parish (7%) have all increased in population since the hurricane. Many businesses have also relocated from Orleans Parish to Jefferson and St. Tammany Parishes. All of these parishes have slowly increased in population since six months following Hurricane Katrina (Warner, 2006).

Tables 3-18 through 3-30 contain the analysis area's current baseline and projections for population, employment, business patterns, and income and wealth through 2030. These tables present projections by MMS-defined EIA. Projections through 2030 are based on the Woods & Poole's *Complete Economic and Demographic Data Source* (Woods & Poole Economics, Inc., 2006). These baseline projections assume the continuation of existing social, economic, and technological trends at the time of the forecast. Therefore, the projections include population and employment associated with the continuation of current patterns in OCS leasing activity as well as the continuation of trends in other industries important to the region. These projections include Woods & Poole's assumptions regarding Hurricane Katrina's impact on the Southeast. From 2005 to 2006, population, income, and employment were assumed to decline 86 percent in St. Bernard Parish, Louisiana; 66 percent in Orleans Parish, Louisiana; 51 percent in Plaquemines Parish, Louisiana; 16 percent in Hancock County, Mississippi; and 11 percent in Jefferson Parish, Louisiana. Some surrounding parishes and counties were similarly assumed to have population and employment gains because of Hurricane Katrina displacement. St. Tammany Parish, Louisiana, was assumed to gain 27 percent; St. John the Baptist Parish, Louisiana, 21 percent; St. James Parish, Louisiana, 14 percent; Ascension Parish, Louisiana, 10 percent; East Baton Rouge Parish, Louisiana, 10 percent; Stone County, Mississippi, 15 percent; St. Charles Parish, Louisiana, 18 percent; and Tangipahoa Parish, Louisiana, 18 percent from 2005 to 2006. Over the forecast period, Woods & Poole's 2006 forecast of Hurricane Katrina's impact assumes that all of the population, employment, and income gains and losses from Hurricane Katrina will mitigate and that New Orleans, Louisiana, will fully recover (Woods & Poole Economics, Inc., 2006).

Table 3-34 presents population projections for eight counties and parishes that were the most negatively affected by Hurricanes Katrina and Rita in terms of population and employment losses: St. Bernard, Orleans, Plaquemines, Jefferson, and Cameron Parishes, Louisiana; and Hancock, Jackson, and Harrison Counties, Mississippi. Many of these communities lost a substantial proportion of their population following the 2005 hurricane season. In general, the Mississippi Gulf Coast is expected to recover its population more quickly than the heavily impacted Louisiana parishes. For example, Jackson and Harrison Counties are projected to increase to their pre-hurricane level by 2009. Although the Louisiana parishes are projected to have a much slower population growth rate, all of the communities (except for Orleans Parish) are expected to completely recover by 2030. **Table 3-35** presents the baseline population projections for each EIA through 2046 that are used to analyze population impacts of proposed actions in **Chapter 4.2**.

3.3.5.4.2. Age

Tables 3-18 through 3-30 present population trends and projections for the Gulf Coast EIA from 1990 to 2030. The area is projected to increase in population throughout the period, with a considerable shift in age structure. Until 2015 (including the 2007-2012 period being considered in this analysis), when the baby boomers retire, the fastest growing age group will continue to be the 50- to 64-year olds. After 2015, the proportion in the 50-64 age group, as well as the younger age groups begin to decline. Meanwhile, the age structure of the region will shift toward the more elderly. For example, the 65 and older age group increases from 13.3 percent of the total population in 2006 to over 19 percent in 2030.

Differences in age structure, as well as net migration, among the coastal EIA's could create variations in population growth. The highest rates of growth between 2006 and 2030 are expected adjacent to the WPA and the lowest adjacent to the CPA. The southern Florida and western southeastern Texas areas are projected to have the highest growth rates, generally exceeding those expected for Louisiana, Mississippi, and Alabama. The lowest population growth rates are expected in the Louisiana EIA's. An exception is EIA LA-4, which is expected to have the highest population growth rate (55%) over this period due to the large population loss in the New Orleans metropolitan area following Hurricane Katrina. The EIA MS-1, which includes the Biloxi-Gulfport metropolitan area, is also expected to increase its population approximately 30 percent between 2006 and 2030. This high growth rate is also largely due to the substantial population loss that occurred after Hurricane Katrina (Woods & Poole Economics, Inc., 2006). (See **Chapter 3.3.5.4.1**, Population, for further discussion of the effect of Hurricanes Katrina and Rita on the elderly population).

3.3.5.4.3. Race and Ethnic Composition

The racial and ethnic composition of the analysis area reflects both historical settlement patterns and current economic activities. For example, those counties in Texas where Hispanics are the dominant group—Cameron to Nueces (Brownsville to Corpus Christi)—were also first settled by people from Mexico. Their descendants remain, typically working in truck farming, tending cattle, or in low-wage industrial jobs. From Aransas to Harris County (Houston), the size of the African-American population increases, indicating more urban and diverse economic pursuits. In Jefferson County, Texas, adjacent to Louisiana, African-Americans outnumber Hispanics, reflecting the dominant minority status of African-Americans throughout the rest of the analysis area. Despite the larger number of white, non-Hispanic people in coastal Texas, Louisiana, Mississippi, and Alabama, together African-Americans and Hispanics outnumber whites, a trend which is national, not just regional, and which is increasing in intensity (Donato and Hakimzadeh 2006) (See **Chapter 3.3.5.4.1**, Population, for further discussion of the effect of Hurricanes Katrina and Rita on minority populations). For example, it is estimated that approximately 45 percent of construction workers involved in the rebuilding effort and living in New Orleans, Louisiana, are Latino, of which 54 percent is undocumented (Fletcher et al., 2006). Compared with the U.S., there is a higher non-white racial composition to the Texas, Louisiana, Mississippi, and Alabama coastal areas with the exception of EIA TX-1. This EIA borders Mexico and has the highest concentration of Hispanic population. Southwestern Louisiana is Acadian country. Settlers included Houma Indians, French, Spanish, English, and African. The Florida EIA's racial composition predominantly mirrors that of the U.S., with the exception of EIA FL-2, which has a higher African-American population. (See **Chapter 3.3.5.10**, Environmental Justice, for further discussion of minority and low-income populations.)

3.3.5.5. Economic Factors

Tables 3-18 through 3-30 contain the analysis area's current baseline and projections for population, employment, business patterns, and income and wealth through 2030. These tables present projections by MMS-defined EIA. Projections through 2030 are based on the Woods & Poole's *Complete Economic and Demographic Data Source* (Woods & Poole Economics, Inc., 2006). These baseline projections assume the continuation of existing social, economic, and technological trends at the time of the forecast. Therefore, the projections include employment associated with the continuation of current patterns in OCS leasing activity as well as the continuation of trends in other industries important to the region. These projections include Woods & Poole's assumptions regarding Hurricanes Katrina and Rita's impact on the Southeast. From 2005 to 2006, population, income, and employment were assumed to decline 86 percent in St. Bernard Parish, Louisiana; 66 percent in Orleans Parish, Louisiana; 51 percent in Plaquemines Parish, Louisiana; 16 percent in Hancock County, Mississippi; and 11 percent in Jefferson Parish, Louisiana. Some surrounding parishes and counties were similarly assumed to have population and employment gains because of Katrina displacement. St. Tammany Parish, Louisiana, was assumed to gain 27 percent; St. John the Baptist Parish, Louisiana, 21 percent; Lamar County, Mississippi, 19 percent; St. Charles Parish, Louisiana, 18 percent; and Tangipahoa Parish, Louisiana, 18 percent from 2005 to 2006. Over the forecast period, Woods & Poole's initial forecast of Katrina's impact assumes that all of the population, employment, and income gains and losses from Katrina will mitigate and that New Orleans will fully recover (Woods and Poole Economics, Inc., 2006).

While the OCS industry may not be the dominant industry in an individual EIA, it can be in a specific locale within an EIA, causing that focal point to experience impacts. For example, in Port Fourchon and Lockport, Louisiana, there has been an influx of workers from Mexico, India, and other parts of the U.S. because of the shortage of local workers in the local community. While these new residents are expected to only negligibly impact the EIA's demographics, they have presented the communities with added stress to infrastructure and government services. Many of these increased costs to local governments are hard to quantify. Some locally provided services are tied to the unique needs of the oil and gas offshore industry.

For example, schools, city water, law enforcement, and roads have been particularly affected by the growth of offshore development (Keithly, 2001; Barrios, 2006; Boulet, 2006c).

3.3.5.5.1. Employment

Average annual employment growth projected from 2005 through 2030 range from a low of 1.22 percent for EIA LA-4 to a high of 2.50 percent for EIA FL-1 in the western panhandle of Florida. Over the same time period, employment for the United States is expected to grow at about 1.57 percent per year, while the GOM economic impact analysis area is expected to grow at about 1.73 percent per year. As stated above, this represents growth in general employment for the EIA's. Continuation of existing trends at the time of the forecast (i.e., post-Katrina and Rita), both in OCS activity and other industries in the area, are included in the projections. (See **Chapter 3.3.5.8** for a more complete examination of employment and labor issues with respect to each OCS industry.)

The widespread destruction caused by Hurricanes Katrina and Rita will have both short- and long-term employment consequences. In October 2005, the Congressional Budget Office (CBO) estimated that between 280,000 and 400,000 people lost jobs directly because of Hurricane Katrina and an additional 12,600-80,000 lost jobs directly because of Hurricane Rita (CBO, 2005). However, the storms' initial adverse impacts will likely fade over time as many employees return to their former jobs or find new ones. Furthermore, the total employment impact in the region will include the positive employment impacts that accompany cleanup and rebuilding as well as the direct negative effects. Over the long term, the total employment in the GOM region may return to levels similar to what it would have been if the hurricanes had not occurred. However, the types of jobs may change and unemployment levels may persist in individual counties and parishes for a long time. The longer term hurricane employment impacts in the region are likely to be in Louisiana and Mississippi, particularly in the metropolitan statistical areas (MSA's) of New Orleans (LA-4) and Biloxi-Gulfport and Pascagoula (MS-1), largely because of the loss of available housing. According to the *Louisiana Economic Outlook: 2006-2007* (LEO), over 267,000 housing units were lost in the State, 75 percent of which were in the New Orleans area (Wall, 2006). An additional 61,000 units were rendered uninhabitable in Biloxi-Gulfport and 41,000 units in Pascagoula (Scott, 2006).

Table 3-34 presents employment projections for eight counties and parishes that were the most negatively affected by Hurricanes Katrina and Rita in terms of population and employment losses: St. Bernard, Orleans, Plaquemines, Jefferson, and Cameron Parishes, Louisiana; and Hancock, Jackson, and Harrison Counties, Mississippi (Woods & Poole Economics, Inc., 2006). Many of these communities lost a substantial proportion of their employment level following the 2005 hurricane season. In general, the Mississippi Gulf Coast is expected to recover its employment level more quickly than the heavily impacted Louisiana parishes. For example, Jackson and Harrison Counties in Mississippi are projected to recover to their pre-hurricane level by 2009, while St. Bernard and Orleans Parishes in Louisiana will only be at 28 percent and 42 percent of their 2005 pre-storm employment levels by 2009. Although the Louisiana parishes are projected to have a much slower employment growth rate, all of the parishes are expected to completely recover by 2030. **Table 3-41** presents the baseline employment projections for each EIA through 2046; these projections that are used to analyze employment impacts of proposed actions in **Chapters 4.2.1.1.13.3 and 4.2.2.1.15.3.** The MMS will continue to update baseline employment numbers in future documents as new information becomes available from Woods & Poole Economics, the U.S. Department of Labor's Bureau of Labor Statistics, individual State data, and published reports.

3.3.5.5.2. Income and Wealth

Median household income in the United States was $44,389 in the 2004. This value equaled the value for 2003 in real terms. Median incomes for Hispanic (who may be of any race) and Black (African-American) households was $34,241 and $30,134, respectively. The median household income for white non-Hispanics was $48,977, and Asian households had the highest level of median income ($57,518) (USDOC, Bureau of the Census, 2005a).

Income associated with the industrial sectors for the WPA EIA's and that of the CPA are similar. Because the service industry is a major employer in the analysis area, this industry contributes significantly (percentage-wise) to income. The manufacturing and construction industries also contribute greatly, in percentage terms, towards income earned for the EIA's.

The Woods and Poole Wealth Index is a measure of relative wealth, with the U.S. having a value of 100. The Wealth Index is the weighted average of regional income per capita divided by U.S. income per capita (80% of the index), plus the regional proportion of income from dividends/interest/rent divided by the U.S. proportion (10% of the index), plus the U.S. proportion of income from transfers divided by the regional proportion (10% of the index). Thus, relative income per capita is weighted positively for a relatively high proportion of income from dividends, interest, and rent, and negatively for a relatively high proportion of income from transfer payments. In 2005, all EIA's within the GOM analysis, with the exception of FL-4 (which had an index of 110.29), ranked below the U.S. in terms of wealth. The next two highest EIA's were TX-3 and LA-4, with indices of 83.76 and 81.73, respectively. The EIA FL-2 ranked the lowest of all EIA's in the region, with an index of 64.26. The Florida EIA's comprise the portion of the analysis area that is least influenced by OCS development. The EIA's with the next lowest wealth indices are MS-1 and AL-1, with 68.82 and 69.20, respectively.

Of the 132 counties that comprise the GOMR economic analysis area, only 12 ranked above the U.S. (6 in FL-4; 2 in TX-3; and 1 in FL-1, FL-3, LA-4, and TX-1). Collier County in FL-4 was the highest, with an index of 150.05. The lowest county is Starr County in TX-1 with an index of 36.49, followed by Hamilton County in FL-2 with 47.94 and Union County in FL-3 with 49.09. (See **Chapter 3.3.5.10,** Environmental Justice, for further discussion of minority and low-income populations.)

3.3.5.5.3. Business Patterns by Industrial Sector

As shown in **Tables 3-18 through 3-30**, the industrial composition for the EIA's in the WPA and that in the CPA are similar. In 2005, the top three ranking sectors in terms of employment in all EIA's in the analysis area, except FL-4, were the services, retail trade, and State and local government sectors – with the service industry ranking number one in all EIA's and retail trade ranking second in all EIA's, except FL-2, where State and local government is second. In FL-4, the top three rankings sectors were services; retail trade; and finance, insurances and real estate, in that order, with State and local government a close fourth. In EIA's TX-1, LA-1, LA-3, and FL-2, construction ranks fourth; in EIA's AL-1, MS-1, and TX-2, manufacturing ranks fourth; in EIA's LA-4, TX-3, and FL-3, finance, insurance, and real estate rank fourth; and in EIA LA-2, mining ranks fourth.

As part of its economic impact analysis in **Chapter 4**, MMS uses IMPLAN's input-output model. A set of multipliers is created for each EIA in the analysis area based on each EIA's unique industry make-up described above. An assessment of the change in overall economic activity for each EIA is then modeled as a result of the expected changes in economic activity associated with holding a CPA or WPA lease sale.

The U.S. Department of Agriculture's Economic Research Service (ERS) classifies counties into economic types that indicate primary land-use patterns (U.S. Dept. of Agriculture, ERS, 2004). Most notably, only 5 of the 132 counties in the analysis area are classified by ERS as farming dependent. Nine counties are defined as mining dependent, suggesting the importance of oil and gas development to these local economies (3 in TX-1, 3 in LA-2, 2 in LA-3, and 1 in LA-4). Manufacturing dependence is noted for another 27 of the counties. Local school districts and public facilities, such as hospitals and prisons, are often the largest employers in sparsely populated rural areas. Thus, it is not surprising that 16 rural counties and 14 metropolitan counties are classified as government employment centers. Another 21 counties have economies tied to service employment. The ERS also classifies counties in terms of their status as a retirement destination; 39 of the 132 counties are considered major retirement destinations, and 7 of the rural counties are classified as recreation dependent. The varied land-use patterns are displayed in **Figure 3-16**.

3.3.5.6. Non-OCS-Related Marine Transport

An extensive maritime industry exists in the northern GOM. **Figure 3-17** shows the major ports and domestic waterways in the analysis area, while **Table 3-36** presents the 2004 channel depth, number of trips, and freight traffic of OCS-related waterways. Maritime traffic is either domestic or foreign. There is a substantial amount of domestic waterborne commerce in the analysis area through the Gulf Intracoastal Waterway (GIWW), which follows the coastline inshore and through bays and estuaries, and in some cases offshore. In addition to coastwise transport between GOM ports, foreign maritime traffic is extensive. Major trade shipping routes between Gulf ports and ports outside the northern GOM occur via the Bay of Campeche, the Yucatan Channel, and the Straits of Florida.

Eight of the leading 25 U.S. ports (based on short tons in 2004) are located on the GOM. All five Gulf States, when ranked by state tons in 2004, are in the top 20 (1-Texas, 2-Louisiana, 6-Florida, 10-Alabama, and 15-Mississippi), reflecting the importance of the analysis area's ports to U.S. waterborne traffic. Major ports in the analysis area by port tons for 2004 include 1-South Louisiana, Louisiana; 2-Houston, Texas; 6-Corpus Christi, Texas; 7-New Orleans, Louisiana; 9-Texas City, Texas; 10-Baton Rouge, Louisiana; 11-Mobile, Alabama; 12-Lake Charles, LA; and 13-Port of Plaquemines, Louisiana (AAPA, 2004). Major inland waterways include the Gulf Intracoastal Waterway; the Houston-Galveston Ship Channel; the Sabine River; the Calcasieu River; the Atchafalaya River; the Morgan City-Port Allen Route; the Chene, Bouef, and Black Waterway; the Houma Navigation Canal; the Bayou Lafourche/West Belle Pass; the Mississippi River; the Tombigbee River; the Alabama River; and the Mobile Ship Channel (USACE, 2001a).

In terms of tonnage for all commodities, including domestic or foreign, inbound or outbound, the top six ports in 2004, in decreasing order, were the Port of South Louisiana; Houston, Texas; New York/New Jersey; Beaumont, Texas; Long Beach, California; and Corpus Christi, Texas (AAPA, 2004).

Crude and petroleum products make up a large portion of total commodities transported through the analysis area's ports. Extensive refinery capacity, easy port access, and a well-developed transportation system have contributed to the development of the Gulf Coast region as an important center for handling oil to meet the world's energy needs. Both crude oil and petroleum products travel through the Gulf and these ports. Crude oil is tankered into area refineries from domestic production occurring in the Atlantic and Pacific Oceans. Crude oil produced within the GOM region is barged among Gulf terminals to reach refineries and onshore transportation routes. Petroleum products are barged, tankered, piped, or trucked from the large refinery complexes. Over 60 percent of the crude oil being imported into the U.S. comes through GOM waters (USDOE, EIA, 2006a). The area also includes the Nation's Strategic Petroleum Reserve and LOOP, the only deepwater crude-oil terminals in the country.

As reported by the Corps of Engineers (COE), almost 50 percent (59.7 million short tons) of the freight traffic on the Gulf Intracoastal Waterway in 2004 was petroleum and petroleum products. This share has remained stable for the past 20 years. The second largest commodity group was chemicals and related products (22% or 26.8 million short tons) (USACE, 2004a).

In 2004, 11.9 million short tons of the freight traffic on the Louisiana portion of the Gulf Intracoastal Waterway was crude petroleum. This accounts for 15 percent of all commodities. The commodity group of petroleum and petroleum products totaled 38.4 million short tons, or 47 percent of all commodities. This group includes gasoline, kerosene, distillate and residual fuel oils, naptha and solvents, petroleum coke and liquefied natural gas (USACE, 2004b).

A number of traditionally bulk transportation ports are making large investments in diversifying their facilities. The Port of Lake Charles is spending $98 million during the next five years for infrastructure improvements to accommodate its growing breakbulk and container business. This includes construction of a 200,000-ft^2 warehouse expansion, two new 100,000-ft^2 warehouses, 6 ac of paved marshalling yard to ease container handling, a new dock, unloading pier, and mooring dolphins for Pelican Refinery's LNG facility. The port spent more than $3.4 million on improvements in 2005 to bolster container and general cargo volume. The Port of South Louisiana, whose mostly bulk cargoes make it the largest tonnage port in the Western Hemisphere, has been expanding intermodal connections and adding industrial tenants, including two manufacturing companies that were displaced by Hurricane Katrina from the Port of New Orleans (Myers, 2006).

As discussed in **Chapter 3.3.5.8.1**, some ports suffered debilitating damage from the 2005 hurricanes, while some were barely affected. At the Port of New Orleans, the first cargo ship after Hurricane Katrina was unloaded 2 weeks after the storm, months before expected (Alexander and Irwin, 2005).

The following impacts from Hurricane Katrina on the Port of New Orleans alone, as summarized by the American Association of Port Authorities, emphasize the importance of ports and cargo and their interrelated nature with the economy: Freight railroads whose lines through the New Orleans area were damaged by Hurricane Katrina detoured rail traffic as far north as Chicago, 900 mi to the north. Trains were stopped as far as 400 mi from New Orleans on CSX Corp.'s lines and up to 200 mi (322 km) from the city on Norfolk Southern Corp. rails. About 100 freight trains a day serve New Orleans, one of the cities where Eastern railroads such as CSX deliver shipments and exchange traffic with Western lines such as Union Pacific. Flooding from Hurricane Katrina placed about 8 percent of the world's coffee supply, which is stored in warehouses in New Orleans, under threat. Néstor Asorio, executive director of the International Coffee Organisation, estimated that the loss of the 96,000 tonnes of coffee stored in New Orleans would take a year to replace and would raise the price of coffee (AAPA, 2005).

Imports of crude and petroleum products into the GOM are projected to increase (USDOE, EIA, 2006a). In 2004, approximately 5.4 MMbbl per day of crude oil and 1.5 MMbbl per day of refined products moved through analysis area ports. This represents about 54 percent of total U.S. imports. By the year 2030 these volumes are projected to grow to 7.3 MMbbl per day of crude oil and 2.6 MMbbl per day of refined products (USDOE, EIA, 2006a). Crude oil will continue to be tankered into the GOM for refining from Alaska, California, and the Atlantic.

3.3.5.7. OCS-Related Offshore Infrastructure

3.3.5.7.1. Offshore Production Systems

Unless otherwise indicated, the following information is from the MMS study, *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (The Louis Berger Group, Inc., 2004) and *Deepwater Development: A Reference Document for the Deepwater Environmental Assessment Gulf of Mexico OCS (1998 through 2007)* (Regg et al., 2000).

Offshore production systems or platforms play a pivotal role in the development of offshore oil and gas resources. The purpose of a platform is to house production and drilling equipment and living quarters for personnel (for manned platforms). A platform can consist of an underwater part (jacket or tower), an above water part (deck), living quarters, control building, and production modules. Several types of production systems are used for offshore oil and gas development in the GOM (**Figure 3-19**). Tables in **Appendix A.5** present information on platforms operating in the OCS.

A fixed platform is a large skeletal structure extending from the bottom of the ocean to above the water level. A fixed platform (**Figure 3-19**) consists of a jacket (a vertical section made of tubular steel members supported by piles driven into the seafloor) with a deck section to provide space for crew quarters, a drilling rig, other equipment, storage, and production and support facilities. Fixed platforms have economic water-depth limits of about 600 m (2,000 ft) (NaturalGas.org, 2006a; USDOI, MMS, 2006d and e; Oynes, 2006).

A compliant tower is similar to a fixed platform; however, the underwater section is not a jacket but a narrow, flexible tower which, because of the flexibility of its structure, can move around in the horizontal dimension, thereby withstanding significant wave and wind impact. A compliant tower consists of a piled foundation that usually supports a narrow, tubular steel trellis-type tower. The structure is kept on station by guyed wires anchored to the seabed or stressed members within the tower. A conventional deck sits on top of the tower for drilling, workover, and production operations. Compliant towers are typically installed in water depths from 300 to 900 m (1,000 to 3,000 ft) (NaturalGas.org, 2006a; USDOI, MMS, 2006d and e; Oynes, 2006).

A tension-leg platform (TLP) consists of a floating structure or hull held in place by tensioned tendons connected to a foundation on the seafloor that is secured by piles driven into the seabed. The tensioned tendons provide a broad depth range of utilization and also limit the TLP's vertical motion and, to a degree, its horizontal motion. At present, TLP's can be used in water depths up to approximately 2,100 m (6,890 ft). Mini-TLP's, a scaled down TLP, may be used to produce smaller reservoirs, satellite fields, or early production structures for larger deepwater discoveries. Operators may consider using mini-TLP's for prospects in water depths from 180 to 1,100 m (2,625-3,609 ft). The deepest TLP in the world was installed by ConocoPhillips at Magnolia in December 2004 at 4,674 feet of water (NaturalGas.org, 2006a; USDOI, MMS, 2006d and e; Oynes, 2006).

A spar structure is a deep-draft, floating caisson that may consist of a large-diameter (27.4-36.6 m) (90-120 ft) cylinder or a cylinder with a lower tubular steel trellis-type component (truss spar, a second generation design) that supports a conventional production deck. A third generation of spar design is the cell spar. The cell spar's hull is composed of several identically sized cylinders surrounding a center cylinder. In July 2004, Kerr-McGee began production from the world's first cell spar at Red Hawk (Garden Banks Block 877) in 1,626 m (5,334 ft) of water. The cylinder or hull may be moored via a chain catenary or semi-taut line system connected to 6-20 anchors on the seafloor. Spars are now used in water depths up to 900 m (2,952 ft) and may be used in water depths 3,000 m (9,842 ft) or deeper (Natural Gas.org, 2006a; USDOI, MMS, 2006d and e; Oynes, 2006).

Semisubmersible production structures (semisubmersibles) resemble their drilling rig counterparts and are the most common type of offshore drilling rig (NaturalGas.org, 2006a). Semisubmersibles are partially submerged with pontoons that provide buoyancy. Their hull contains pontoons below the waterline and vertical columns to the hull box/deck. The structures keep on station with conventional catenary or semi-taut line mooring systems connected to anchors in the seabed. Semisubmersibles can be operated in a wide range of water depths. Floating production systems are suited for deepwater production in depths up to 8,000 ft (2,438 m) (NaturalGas.org, 2006a; USDOI, MMS, 2006d and e; Oynes, 2006).

For some development programs, especially those in deep- and ultra-deepwater, an operator may choose to use a subsea production system instead of a floating production structure. Unlike wells from conventional fixed structures, subsea wells do not have surface facilities directly supporting them during their production phases. A subsea production system comprises various bottom-founded components, among them: well templates, well heads, "jumper" connections between well heads, control manifolds, in-field pipelines and their termination sleds, and umbilicals and their termination assemblies. A subsea production system can range from a single-well template connected to a nearby manifold or pipeline, and then to a riser system at a distant production facility; or a series of wells that are tied into the system. Subsea systems rely on a "host" facility for support and well control. Centralized or "host" production facilities in deep water or on the shelf may support several satellite subsea developments. A drilling rig must be brought on location to provide surface support to reenter a well for workovers and other types of well maintenance activities. In addition, should the production safety system fail and a blowout result, surface support must be brought on location to regain control of the well.

One recent integrated subsea gas development involving multiple operators will use a semisubmersible topsides, 176 mi (281 km) of in-field flowlines, and produce 21 or more wells in 10 fields. This integrated surface "host" and subsea production system is in water approximately 2,438 m (8,000 ft) deep in Mississippi Canyon Block 920 and is called the Independence Hub. The Hub is likely to be a model for smaller discoveries that lie in deep- and ultra-deepwater settings because of the economic challenges of producing smaller discoveries from these depths. The Hub is now under construction and is projected to eventually produce 1 Bcf of gas per day beginning in 2007 from fields in the eastern CPA that were not economic to produce individually (USDOI, MMS, 2005b). Currently, the deepest subsea system is Shell's Coulomb Field in Mississippi Canyon Block 657. Six fields range in depth from 1,768 to 2,362 m (5,800 to 7,750 ft) and are tied back to a host facility by a 25-mi pipeline (NaturalGas.org, 2006; USDOI, MMS, 2006d and e; Oynes, 2006; FMC Technologies.com, 2006).

Although the use of subsea systems has recently increased as development has moved into deeper water, subsea systems are not new to the GOM and they are not used exclusively for deepwater development. The first subsea wells in the GOM were installed in 1964 in water depths of a few tens of meters. Subsea systems are being installed at ever-increasing water depths. Subsea systems in the GOM are currently expected to be deployed in deep- and ultra-deepwater settings. Operators are contemplating subsea developments to depths of 3,000 m (9,842 ft) and greater.

The MMS has prepared an EIS on the potential use of floating production, storage, and offloading (FPSO) systems on the GOM OCS (USDOI, MMS, 2002b). In accordance with the scenario provided by industry, the FPSO EIS addresses the proposed use of FPSO's in the deepwater areas of the WPA and CPA only. In January 2002, MMS announced its decision to accept applications for FPSO's after a rigorous environmental and safety review. The FPSO systems have been used around the world; however, to date, MMS has not received any proposals for use of FPSO systems in the GOM (USDOI, MMS, 2006d; *International Oil Daily*, 2006; USDOI, MMS, 2002b). The FPSO system is an especially good production system candidate for deployment in ultra-deepwater situations where the nearest pipeline tiebacks could be hundreds of miles away. Operators making recent large discoveries in remote areas, such as in the Perdido Fold belt in the WPA and the edge of the Sigsbee Escarpment in the CPA, may have no recourse other than to deploy an FPSO system to produce discoveries in these areas. Among the challenges facing an FPSO deployment in these areas is the fate of produced gas from the reservoirs. The MMS has funded studies to examine options to safely produce the associated gas reserves. Compressed gas, gas to liquids, LNG, and other options were considered. A new and evolving technology for deepwater development involves the use of minimal floating structures. These buoy-like structures allow the placement of minimal equipment at the surface. They have the advantages of relatively low cost and surface access to the well(s). These structures are dependent on "host" facilities for control and for final processing of the produced hydrocarbons.

Fabrication

Platforms are fabricated onshore and then towed to an offshore location for installation. Facilities where platforms are fabricated are called platform fabrication yards. Production operations at fabrication yards include the cutting and welding of steel components and the construction of living quarters and other structures, as well as the assembly of platform components. Fixed platform fabrication can be subdivided into two major tasks: jacket fabrication and deck fabrication.

The jacket is constructed by welding together steel plates and tubes to form a tower-like skeletal structure. Because the height of a jacket is several hundred feet, jackets are made lying horizontally on skid runners. Once the jacket is completed, it is pulled over, maintaining the same horizontal position, to a barge that transports it to an offshore location where the jacket is installed. Along with the jacket is the construction of smaller ancillary structures such as pile guides, boat landings, walkways, buoyancy tanks, handrails, etc. These structures are attached to the jacket while it is still in a horizontal position.

The deck is fabricated separately from the jacket. A typical deck is a flat platform supported by several vertical columns (deck legs). The deck provides the necessary surface to place production equipment, living quarters, and various storage facilities. Once the deck fabrication is completed, it is loaded onto a barge and transported to the site of the platform, where it is lifted by derrick barges and attached to the already installed jacket.

3.3.5.7.2. Offshore Transport

3.3.5.7.2.1. Pipelines

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the GOM. These products include unprocessed (bulk) oil and gas; mixtures of gas and condensate; mixtures of gas and oil; processed condensate, oil, or gas; produced water; methanol; and a variety of chemicals used by the OCS industry offshore. As of June 2006, there were more than 37,000 km (22,991 mi) of active OCS pipelines. These pipelines are designated as either trunklines or gathering lines. Gathering lines are typically shorter segments of small-diameter pipelines that transport the well stream from one or more wells to a production facility or from a production facility to a central facility serving one or several leases, e.g., a trunkline or central storage or processing terminal. Trunklines are typically large-diameter pipelines that receive and mix similar production products and transport them from the production fields to shore. A trunkline may contain production from many discovery wells drilled on several hydrocarbon fields. The OCS-related pipelines near shore and onshore may merge with pipelines carrying materials produced in State territories for transport to processing facilities or to connections with pipelines located further inland. Most of the active length of OCS pipelines transport either gas (59%) or oil (27%).

Over the last 10 years, the average annual installation rate for OCS pipelines was 1,600 km (994 mi) and more than 250 pipelines and pipeline segments. Pipelines in the CPA accounted for 83 percent of the length installed; pipelines in the WPA accounted for 17 percent. The installation rate for pipelines is expected to remain steady; this includes consideration of expansion and replacement of the existing and aging pipeline infrastructure in the GOM.

3.3.5.7.2.2. Barges

Barges may be used offshore to transport oil and gas, supplies such as chemicals or drilling mud, or wastes between shore bases and offshore platforms. Barges are non-self-propelled vessels that must be accompanied by one or more tugs. Because of this, barge transport is usually constrained to shallow waters of the GOM, close to the shoreline.

Barging of OCS oil from platforms to shore terminals (**Chapter 3.3.5.8.6.2**) is an option used by the oil industry in lieu of transporting their product to shore via pipeline. A platform operator generally decides at the beginning of a development project whether the production will be barged or piped. Other types of barging operations may occur in connection with OCS operations. Besides barging from platform to shore terminal, a few platform operators choose to barge their oil to other platforms where it is then offloaded to storage tanks and later piped to shore. Barging is used very infrequently as an interim transport system prior to the installation of a pipeline system.

The barging of oil from offshore platforms located in the GOM has remained constant and continues to represent a small portion of the total volume of OCS oil being transported to shore. The number of barging systems remains at approximately eight. At present, there are 30 offshore platforms approved to barge oil. Of these locations, 18 barge oil on a regular basis. The remaining 12 locations either barge oil on an infrequent basis (once or twice a year) or have ceased oil production.

Historically, the percentage of OCS oil barged has remained less than 1 percent of the total volume of OCS oil being transported to shore. During 2005, that percentage has remained less than 1 percent with the exception of the month following Hurricanes Katrina and Rita. During the month of September 2005, the total oil production in the GOM declined sharply because of damaged platforms and pipelines. Because the platforms that previously barged the oil from their locations were not affected by pipeline damage, the barged volume was relatively unaffected. Since the total oil production declined sharply, the percentage of barged oil for the month of September rose to 1.29 percent. As pipelines were repaired and alternate routes were approved, oil production in the GOM increased steadily. By December 2005, the percentage of total oil that was barged returned to the pre-hurricane rate of approximately 0.5 percent.

Immediately after the hurricanes, there were requests for both permanent and temporary barging approvals. These requests did not significantly increase the total volume of oil being barged. Many of these requests were for the one time removal of stored production or production remaining in the processing equipment on damaged platforms.

Nearly all of the offshore platforms actively barging are located in the CPA. Platforms east of the Mississippi River account for roughly 62 percent of the total volume of OCS barged oil. Likewise, locations offshore Louisiana located west of the Mississippi River account for the remaining 38 percent. Two locations in the WPA, off Texas, have minimal barging activity.

3.3.5.7.2.3. Service Vessels

Unless otherwise indicated, the following information is from *The Offshore Supply Boat Sector* (Barrett, 2005).

The GOM is a very developed market with ample infrastructure, so there tends to be more boat types than in other international locations. The main types of vessels used in the GOM offshore industry include anchor handling towing supply (AHTS), offshore supply vessels (OSV), and crewboats. There is a large fleet of offshore tugs (AHTS vessels) whose sole job is to tow rigs from one location to another and to position the rig's anchors. This differs from many international locations, where boats that tow rigs usually serve other functions as well, such as carrying supplies. Offshore supply vessels deliver drilling supplies such as liquid mud, dry bulk cement, fuel, drinking water, drill pipe, casing, and a variety of other supplies to drilling rigs and platforms. The majority of OSV's in service are old, legacy boats built during the boom in the late 1970's/early 1980's. A typical boat from that era is about 180 ft (55m) long and can carry about 1200 bbl of liquid mud and about 1,000 tons (dead weight tons) of deck cargo. New generation OSV's are between 220 and 295 ft long and can carry 3-10 times as much liquid mud and 2-4 times as much deck cargo. Typical OSV vessel specifications are shown in **Table 3-37**. Many, but not all, of the new generation OSV's are deepwater capable. Crewboats transport personnel to, from, and between offshore rigs and platforms. These boats are much smaller than the AHTS's or OSV's and can range in size from 75 to 190 ft. The smallest boats are typically used to transport crews between offshore installations and not to and from shore.

There are a variety of other types of vessels used by the oil and gas industry, including the following: utility/workboats that perform a lot of work in support of offshore construction projects; survey vessels that collect geophysical data; well stimulation vessels that perform fracturing and acidizing of producing wells; and multi-purpose supply vessels (MPSV) that can provide a combination of remote subsea intervention services, remotely operated vehicle (ROV) operations, deepwater lifting and installation, delivery of supplies, fire fighting, and oil-spill recovery.

The GOM has long been one of the busiest supply-boat markets in the world, a direct result of the historical level of oil-field activity that has taken place in the region. The market is highly competitive, and it is estimated that there are over 150 different boat owners operating over 850 boats in the GOM. Tidewater is the dominant company (and the largest supply boat company in the world); however, it has an aging fleet that is losing more and more business to new, next generation vessels. Seacor (the second largest supply boat company in the world) is also a major player in the GOM. Both Seabulk and Trico Marine also have a significant presence, but like Tidewater, have aging fleets. Edison Chouest Offshore, an early leader in introducing next generation, deepwater capable supply vessels, continues to focus on the Gulf market, as does Hornbeck Offshore, which has the youngest fleet of any significant player in the GOM.

Boat owners in the GOM typically use the spot market to win work rather than using long-term contracts, meaning that the job only lasts as long as the task at hand. Prior to the 2005 hurricane season, day rates had been quite volatile over the last few years and the weaker market had caused many boat owners to leave the market. Heightened activity in the offshore rig market following the 2005 hurricanes has also meant a boom for OSV's. At the end of 2005, with the exception of a handful of vessels at shipyards, every active OSV in the GOM was working. Every vessel owner surveyed indicated that they could immediately put additional vessels to work if any were available (One Offshore, 2005a; 20:11). Day rates are reflecting the tight supply and heavy demand, and some vessel owners feel that they can even name their price in certain situations. The April 2006 average day rates were as follows: AHTS vessels range from $12,500 for under 6,000-hp vessels to $70,000 for over 6,000-hp vessels; supply boats range from $12,500 for boats up to 200 ft and $19,000 for boats 200 ft and over; and crewboats range from $4,800 for boats under 125 ft to $7,667 for boats 125 ft and over (Greenberg, 2006a). In comparison, the April 2005 average day rates were as follows: AHTS vessels ranged from $12,500 for under 6,000-hp vessels to $24,850 for over 6,000-hp vessels; supply boats ranged from $6,025 for boats up to 200 ft and $11,515 for boats 200 ft and over; and crewboats ranged from $2,625 for boats under 125 ft to $4,825 for boats over 125 ft and over (Greenberg, 2006a). As of June 2006, U.S. GOM OSV owners reported that 221 vessels (i.e., every available) were under contract. Operators are seeking long-term commitments, and 1- and 2-year firm deals are becoming more common (One Offshore, 2006c; 20:37).

For the amount of damage Hurricane Katrina inflicted on the oil and gas industry, the offshore supply vessels operators came out relatively unscathed. Most workboat operators reported little or no damage to their fleets, and many were back at work assessing the damage offshore a few hours after the storm had passed. Many vessel operators had moved their fleets west toward Cameron, Louisiana, and as far as Galveston, Texas. (Dupont et al., 2005). Tidewater Inc. reported no damage to its fleet, even though its main headquarters in New Orleans would be uninhabitable for several months. Hornbeck Offshore Services had moved its vessels west to Cameron, Louisiana, and survived the storm. Also, Edison Chouest Offshore's fleet was undamaged. All of L&M Botruc Rental's boats had been moved to Morgan City and some were already in Cameron. And, all went back to work shortly after the storm passed (Dupont et al., 2005).

Shortly after the hurricane, OSV operators were reporting increased demand from operators who were anxious to assess and repair any damage to platforms and rigs. Demand has also come from construction and diving companies that were mobilizing equipment and crews to conduct damage assessments on pipelines. Anchor-handling tugs have been in high demand to reel in floating drilling rigs (Dupont et al., 2005).

The hurricanes of 2005 put an additional premium on offshore supply boats. Tidewater Inc. (New Orleans, Louisiana) has 5 supply vessels and a fast-supply boat under construction; Rigdon (Houston, Texas) ordered 10 platform-supply vessels (PSV) being built at Bollinger Shipyards in Lockport, Louisiana; and Edison Chouest (Galliano, Louisiana) will expand its Gulf fleet with 3 AHTS vessels, 10 new PSV's and 9 fast-supply vessels (Greenberg, 2006b). According to one construction survey, there were 36 supply boats on order in 2004 and 25 in 2005 (Hocke, 2006). As of June 2006, shipyards along the Gulf Coast are booked solid with at least 37 new offshore supply vessels being built. This, in addition to remaining hurricane-related repair projects, has kept the shipyards operating at full capacity (Greenberg and Krapf, 2006).

3.3.5.7.2.4. Helicopters

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. For small parts needed for an emergency repair or for a costly piece of equipment, it is more economical to get it to and from offshore fast rather than by supply boat. Normal offshore work schedules involve 2-week (or longer) periods with some crew changes on a weekly basis; therefore, helicopters will travel to some facilities at least once a week. According to the Helicopter Safety Advisory Conference (2006), from 1996 to 2003, helicopter operations (take offs and landings) in support of Gulfwide OCS operations have averaged, annually, 1.5 million operations, 3.1 million passengers, and 430,000 flight hours.

The Federal Aviation Administration (FAA) regulates helicopter flight patterns. Because of noise concerns, FAA Circular 91-36C encourages pilots to maintain higher than minimum altitudes near noise-sensitive areas. Corporate policy (for all helicopter companies) states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms and drilling rigs. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas and coastlines, and 2,000 ft over populated areas and sensitive areas including national parks, recreational seashores, and wildlife refuges. In addition, guidelines and regulations issued by NOAA Fisheries Service under the authority of the Marine Mammal Protection Act include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals.

Many of the platforms offshore Texas, Louisiana, Mississippi, and Alabama serve as helicopter refueling stations. At present, aircraft fuel is barged to these offshore refueling stations. While there are offshore fueling sites, it saves the industry time and money not to stop. Transportation is one of the exploration and production industry's top three costs. The newer helicopters operating in the GOM, though, have the range and capacity to fly without stopping to refuel, but they are more costly to operate.

Since the tasks the offshore helicopter industry provides are the same tasks supply vessels provide, they are competition for one another. While exploration and production companies like helicopters, the industry is outsourcing more and more operations to oil-field support companies, who are much more cost conscious and skeptical about the high cost of helicopters. Fast boats are beginning to erode the helicopter industry's share of the offshore transportation business, particularly in shallow water. Another consideration for the helicopter industry is subsea systems. As discussed in **Chapter 3.3.5.7.1**, a subsea system consists of a single subsea well or several wells producing either to a nearby platform or to a distant production facility through pipeline and manifold systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

3.3.5.7.3. Damage to Offshore Infrastructure from Recent Hurricanes

The following information is summarized from reports by MMS on the damage to the OCS-related platforms, rigs, and pipelines caused by Hurricanes Ivan, Katrina, and Rita (USDOI, MMS, 2005c-f and 2006f-j). **Chapter 4.1.3.4.4.2**, Spills as the Result of Hurricanes, discusses the cause and volume spills that resulted from recent hurricanes.

Hurricane Ivan (2004)

The MMS estimates that, of the approximately 4,000 structures in the GOM, 150 platforms and 10,000 mi of pipeline were in the direct path of Hurricane Ivan. The range of damaged facilities included mobile drilling rigs, offshore platforms, producing wells, topside systems including wellheads and production and processing equipment, risers, and pipeline systems that transport oil and gas ashore from offshore facilities. Hurricane Ivan destroyed 7 structures (four 8-pile platforms, two caissons, and one 4-pile platform) and significantly damaged 24 others, primarily 8-pile platforms.

Hurricane Ivan's path brought it across the shelf and through the waters of the Mississippi River delta, the area most susceptible to underwater mudslides in the Gulf. Thirteen pipelines were damaged because of mudslides and four additional pipelines with a diameter wider than 10 in were damaged by other forces.

Almost 5 months after Hurricane Ivan, less than 10 percent of oil production and 5 percent of natural gas production remained shut-in. Approximately 98 percent of the major oil and gas platforms in the GOM are now producing. The final report of evacuation and production shut-in statistics, 5 months after Hurricane Ivan, stated evacuations were equivalent to 1.18 percent of 764 manned platforms. The shut-in oil production was equivalent to 7.42 percent of daily production of oil in the GOM, which is approximately 0.64 percent of oil production consumed in the U.S. each day. A few deepwater facilities accounted for 60 percent of the shut-in oil production. The shut-in gas production was equivalent to 1.19 percent of the daily production of gas in the GOM, which is approximately 0.24 percent of the gas production consumed in the U.S. each day. The cumulative shut-in oil production was equivalent to 7.246 percent of the yearly production of oil in the GOM, and the cumulative shut-in gas production is equivalent to 3.871 percent of the yearly production of gas in the GOM.

Hurricanes Katrina and Rita (2005)

Hurricanes Katrina and Rita were both geographically large storms that passed over much of the GOM's offshore oil and gas infrastructure. The MMS estimates that, of the approximately 4,000 structures in the GOM, 3,050 (76%) were in the direct path of either Hurricane Katrina or Hurricane Rita. The latest damage report released by MMS states 113 platforms were destroyed by Hurricanes Katrina and Rita.

The MMS estimates that 22,000 of the 33,000 mi of Gulf pipelines were in the direct path of either Hurricanes Katrina or Rita (2005). Because of the large amount of infrastructure in the path of hurricane-force winds and waves, the amount of damage was substantial. In comparison with Hurricane Ivan, Hurricanes Katrina and Rita accounted for considerably more damage because of the paths taken by these two devastating storms. Based on additional industry assessments, investigations, and reports, the number of pipelines reported damaged is 457. Of those, 101 were larger diameter pipelines (10 in or greater). As of May 1, 2006, 32 pipelines have returned to service.

As of May 1, 2006, four replacement platforms have been proposed by operators and approved by MMS. These replacement platforms will take the place of eight destroyed platforms with a pre-hurricane daily production of 16,700 bbl per day. While some damaged platforms are back online and some are still under repair, others have been damaged beyond repair. Recently, Chevron announced that it would sink its $250 million Typhoon oil platform that was damaged by Hurricane Rita. The Typhoon platform will be donated to a Federal program that uses decommissioned platforms and rigs to create new reefs on the seafloor (Bloomberg.com, 2006).

Over 90 percent of the manned platforms and over 85 percent of the working rigs were evacuated for the hurricanes. The latest report of evacuation and production shut-in statistics, 10 months after Hurricanes Katrina and Rita, stated evacuations were equivalent to 8.30 percent of manned platforms. This report also stated the shut-in oil production is equivalent to 11.998 percent of the daily oil production in the GOM, and shut-in gas production is equivalent to 9.357 percent of the daily gas production. The cumulative shut-in oil production was equivalent to 30.377 percent of the yearly production of oil in the GOM, and the cumulative shut-in gas production is equivalent to 22.017 percent of the yearly production of gas. As of October 1, 2006, additional production has come back online as evidence by the Mars platform with current production figures of 124.5 MBPOD and 133 MMCFPD.

Notice to Lessees

The effects of Hurricanes Ivan, Katrina, and Rita were detrimental to oil and gas operations on the OCS. These effects included structural damage to fixed production facilities, semisubmersibles, jack-ups, and pipelines. The MMS provides hurricane damage assessments, safety alerts, NTL's, and evacuation and production shut-in statistics at http://www.gomr.mms.gov/homepg/whatsnew/hurricane/index.html.

The MMS issued NTL 2005-G20, "Damage Caused by Hurricanes Katrina and Rita," to describe the inspections that needed to be conducted and the plans and reports that needed to be prepared because of the known and potential damage to OCS facilities caused by Hurricanes Katrina and Rita. This NTL superseded NTL 2005-G16 and became effective October 24, 2005. The MMS issued NTL 2005-G20 (Addendum No. 1), effective June 12, 2006, which supplements NTL 2005-G20 by extending the deadlines for conducting damage inspections, submitting inspection results, and completing any repairs. Also, the NTL specifies the contents of monthly inspection and status reports.

The 2004 and 2005 hurricanes did not cause any loss of life on the OCS because of industry's ability to secure wells and evacuate personnel successfully. Under 30 CFR 250.192, operators must submit statistics to MMS on the evacuation of personnel and curtailment of production because of hurricanes, tropical storms, or other natural disasters. Regulations require operators to

(a) submit the statistics by fax or email as soon as possible when evacuation occurs;

(b) submit statistics on a daily basis by 11:00 a.m., as conditions allow, during the period of shut-in and evacuation;

(c) inform MMS when production resumes; and

(d) submit statistics either by MMS district or the total figures for operations in the GOMR.

The MMS uses these data to work interactively with the USCG on rescues and oil spills, and to notify the news media and interested public entities that monitor shut-in production. Effective October 25, 2006, NTL 2006-G19, "Hurricane and Tropical Storm Evacuation and Production Curtailment Statistics," provides guidelines for submitting this information, and it also provides for statistics regarding the number of platforms and drilling rigs not evacuated.

During Hurricanes Ivan, Katrina, and Rita, 9 jack-up rigs and 19 moored rigs experienced a total failure of station-keeping ability. The MMS GOMR is concerned about the loss of these facilities and rigs as well as the potential for catastrophic damage to key infrastructure and the resultant pollution from future storms. In an effort to reduce these effects, MMS set forth guidance to ensure compliance with 30 CFR 250.417 and to improve performance in the area of jack-up and moored rig station-keeping during the environmental loading that may be experienced during hurricanes. Industry, USCG, and MMS worked together to develop interim recommended practices for the use of jack-up and moored rigs during the 2006 hurricane season to potentially decrease the amount of failures during hurricanes. The MMS issued NTL 2006-G10, "Moored Drilling Rig Fitness Requirements for the 2006 Hurricane Season," and NTL 2006-G09, "Jack-up Drilling Rig Fitness Requirements for the 2006 Hurricane Season." These NTL's provide guidance on the information operators must submit with APD's to demonstrate the fitness of any jack-up or moored drilling rig used to conduct drilling, workover, or completion operations in the GOM OCS during the 2006 hurricane season.

Studies

Following Hurricanes Andrew, Lili, Ivan, Katrina, and Rita, MMS funded numerous studies to understand better the effects of these storms on the environment and on the Gulf's infrastructure. **Table A-6** provides a listing of the hurricane-related studies and their objectives. Examples of the study topics include the following: the damage to structures and pipelines; assess the actual wind, wave, and current forces that were present; determine the effectiveness of current design standards and pollution-prevention systems; and develop recommended changes to industry standards and MMS regulations, if needed. Results from the studies will help MMS to prepare better for these natural events.

3.3.5.8. OCS-Related Coastal Infrastructure

Unless otherwise indicated, the following information is from the MMS study, *Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (Louis Berger Group, Inc., 2004).

The OCS development is supported by a large onshore infrastructure industry consisting of thousands of small and large contractors responsible for virtually every facet of the activity, including supply, maintenance, and crew bases. These contractors are hired by majors and independents alike to service production areas, provide material and manpower support, and to repair and maintain facilities along the coasts. The offshore support industry employs thousands of workers and is responsible for billions of dollars in economic activity in the analysis area. Virtually all of these support industries are found adjacent to ports.

For over a half century, the fabrication industry in the analysis area has been the cornerstone for the offshore oil and gas industry and a major contributor to the industry's labor demand. There are hundreds of onshore facilities in the analysis area that support the offshore industry. The fabrication corridor stretches approximately 1,000 mi from the Texas/Mexico border to the Florida Panhandle. Other offshore support industries are responsible for such products and services as engine and turbine construction and repair, electric generators, chains, gears, tools, pumps, compressors, and a variety of other tools. Additionally, drilling muds, chemicals, and fluids are produced and transported from onshore support facilities. Many types of transportation vessels and helicopters are used to transport workers and materials to and from OCS platforms. As technology matures, additional support industries will evolve.

With the expanding interest in deepwater activities, many onshore facilities have migrated somewhat to areas that have capabilities of handling deepwater vessels, which require more draft. Since fewer ports have such access, dredging operations at existing facilities or contractor expansion to areas that can handle such vessels has occurred. This has also led to heated competition between port facilities. Many support industries have multiple locations among the key port facilities. For instance, Bollinger Shipyards has locations in Texas City, Texas, and Calcasieu, Morgan City, Lockport, Larose, Fourchon, Gretna, St. Rose, and Algiers, Louisiana (Bollinger, 2006).

Shipbuilding and repair facilities are located in key ports along the Gulf Coast. A typical shipbuilding facility consists of a variety of structures, including maintenance and repair facilities. These yards are typically found adjacent to a deep ship channel that allows them to serve deepwater vessels. Additionally, these facilities also serve other commercial and military needs in order to diversify and protect themselves against leaner oil industry times.

The marine construction industry is highly competitive. Competition is influenced by such factors as price, availability and capability of equipment and personnel, and reputation and experience of management. Contracts for work in the GOM are typically awarded on a competitive bid basis 1-3 months before execution of the project. Customers usually request bids from companies they believe are technically qualified to perform the project. Although customers consider, among other things, the availability and technical capabilities of equipment and personnel, the condition of equipment, and the efficiency and safety record of the contractor, price is the primary factor in determining which qualified contractor is awarded the contract. Because of the lower degree of complexity and capital costs involved in shallow-water marine construction activities, there are a number of companies with one or more pipelay barges capable of installing pipelines in shallow water.

Companies that compete in the GOM pipelay market in water depths of 200 ft or less are Horizon Offshore, Inc. (Horizon), Global Industries, Ltd. (Global), Cal Dive International, Inc. (Cal Dive), Chet Morrison Contractors, Inc. and a few smaller competitors. Horizon, Global, and Cal Dive also compete in water depths between 200 and 1000 ft (Horizon Offshore Inc., 2005). In the beginning of 2005, the number of pipelaying vessels in the GOM decreased, contributing to the remaining vessels' utilization. Global deployed vessels from its operations in the Gulf to perform work in international areas, and Torch Offshore, Inc. filed a voluntary petition for reorganization under Chapter 11 of the U.S. Bankruptcy Code in January 2005, temporarily removing its vessels and equipment from service.

As a result of these events, and coupled with the unprecedented hurricane and storm activity in the GOM during 2004 and 2005, vessel utilization during 2005 has significantly increased for companies like Horizon and CalDive. More recently, however, additional vessels have been mobilized in the Gulf. And, the demand for pipelay services is currently exceeding the availability of assets and equipment capable of satisfying such demand. It is anticipated that vessel utilization in the U.S. Gulf of Mexico will remain at high levels during 2006 and 2007.

Other support facilities are located near ports, including warehouses for chemicals, muds, tools, and other equipment. Crew quarters and bases are also near ports, but some helicopter facilities are located farther inland. Transportation to and from offshore rigs is a major expense for producers, and many transportation companies exist to provide this service. Often one or two supply ships and at least one helicopter are used to support each platform.

Like onshore development, OCS exploration and production is driven by oil and gas prices. The 1986 collapse of oil prices forced many offshore companies to close their doors, while the remaining companies often consolidated and expanded operations to include commercial and military business. This was true throughout the entire supporting industry infrastructure.

During slow times, all areas feel the effects. Fewer rigs are built and maintained, fewer boats are needed, fewer chemicals are manufactured and purchased, and much less research and development (R&D) is conducted. Perhaps the most detrimental result of a downturn is the flight of many experienced personnel. This has led to severe problems for an industry closely tied to the price volatility of oil and natural gas. When experienced workers leave it is very difficult to entice them back to an industry that is so volatile.

One of the results of fewer R&D dollars is that producers, who are saddled with billion dollar projects, are forced to push much of the R&D expenditures for new technologies onto their suppliers. For example, it is common to see many suppliers shoulder the burden of seismic surveys today. Unfortunately, no single company can adequately fund and support such activities. It is important to realize that new technologies have led to the development of previously unrecognized, unreachable, or uneconomic reserves, which often lead to significant work for the onshore support industry.

Following the massive shift in the industry in the mid-1980's, subsequent price downturns have not been as decimating to the industry, though the 1998-1999 price drop did force companies to lay off employees and to close a few facilities. Drilling declined significantly but did not cause the massive contractor flight evidenced in the mid-1980's. During this downturn, activity shifted somewhat to platform removal, maintenance, renovations, and rig surveys. Some fabrication yards diversified in order to keep their doors open, often taking in non-oil-related work such as barge repair and even military work.

The move into deep water has increased activity and has led to a significant transformation for some contractors. Since ports with sufficient draft to accommodate deepwater-servicing equipment are limited, onshore effects appear to be concentrated in a few communities. This contrasts with earlier, nearer-shore developments that are supported by many ports and coastal communities.

The hurricanes of 2005 impacted every facet of the GOM oil and gas industry – from platform fabrication yards and service bases, to production platforms and drilling rigs, to processing facilities and deliveries to end-users, and everything in between. The impacts to the different sectors and facilities are detailed in the individual sections below. However, one of the most important findings of these sections is that, despite the amazing degree of destruction, these sectors, in large part, were able to recover relatively quickly and most are operating at or near pre-hurricane levels.

The MMS is a sponsor and participant in "The Economic and Market Impacts of Coastal Restoration: America's Wetland Economic Forum II" held in late September 2006. Part of this effort, lead by the L.S.U. Center for Energy Studies, will examine the local, regional, and national infrastructure at risk in the Gulf region, with a particular focus on energy infrastructure. This project will be examining the potential positive impacts that coastal restoration would play in protecting and maintaining energy infrastructure. The study will use GIS tools to simulate coastal erosion and flooding scenarios to identify potential "at risk" energy infrastructure assets along the Gulf Coast, including Louisiana. The recent flooding experiences from Hurricanes Katrina and Rita will be used in case studies to examine recent infrastructure exposure to flooding. Certain scenarios on coastal erosion and flood relationships will be considered as well (i.e., hypotheticals on how coastal restoration could have impacted the degree of flooding, and in turn, the impact on infrastructure). Traditional economic analysis using valuation techniques will be considered, as well as other methods like economic impact approaches. The first phase of this project will be to recommend methods for estimating overall economic impacts of coastal restoration. A case study on one area of infrastructure in the State of Louisiana will be provided. The first phase of the project was completed and presented at the Economic Forum II in late September 2006. The second phase will codify the research into a final research report/paper that will be presented at the end of the year at the 3rd National Conference on Coastal and Estuarine Habitat Restoration, December 9-13, 2006, in New Orleans, Louisiana.

3.3.5.8.1. Service Bases

Unless otherwise indicated, the following information is from the 2004 MMS study, *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (Louis Berger Group, Inc., 2004).

A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel that are needed at offshore work sites. Although a service base may primarily serve the OCS planning area and EIA in which it is located, it may also provide significant services for the other OCS planning areas and EIA's.

The oil and gas industry has thrived in the GOM. With the industry has come a logistical support system that links all phases of the operation and extends beyond the local community. Land-based supply and fabrication centers provide the equipment, personnel, and supplies necessary for the industry to function through intermodal connections at the Gulf Coast ports. The necessary onshore support segment includes inland transportation to supply bases, equipment manufacturing, and fabrication. The offshore support involves both waterborne and airborne transportation modes.

States along the GOM provide substantial amounts of support to service the oil and gas industry that is so active on the OCS (**Figure 3-20**). Many ports offer a variety of services and support activities to assist the industry in its ventures. Personnel, supplies, and equipment must come from the land-based support industry. All of those services must pass through a port to reach the drilling site. **Table 3-31** shows the 50 service bases currently used for the OCS. These facilities were assessed from the MMS Platform Plans' primary service base designation. As can be seen from the **Table 3-31**, 33 of the service bases (or 66%) are located in the CPA. Of these, 29 reside in Louisiana. In addition to servicing the offshore, several of the services bases are commercially oriented ports: Mobile, Alabama; Pascagoula, Mississippi; Lake Charles, Morgan City, and Port of Plaquemines/Venice, Louisiana; and Corpus Christi, Freeport, Galveston, and Port Arthur, Texas. These activities were discussed in **Chapter 3.3.5.6**. The other service bases are a combination of local recreation and offshore service activity.

This extensive network of supply ports includes a wide variety of shore-side operations from intermodal transfer to manufacturing. Their distinguishing features show great variation in size, ownership, and functional characteristics. Basically, two types of ports provide this supply base. Private ports operate as dedicated terminals to support the operation of an individual company. They often integrate both fabrication and offshore transport into their activities. Public ports lease space to individual business ventures and derive benefit through leases, fees charged, and jobs created. These benefits spread throughout the entire area and are viewed as economic development impacts. Thus, the public ports play a dual role by functioning as offshore supply points and as industrial or economic development districts. An efficient network of ports lowers costs associated with oil and gas production and significantly boosts the well-being of citizens of the adjacent communities.

The significant prosperity that has followed the industry has resulted in issues and concerns that must be addressed at the local community level. For example, additional commercial traffic associated with offshore supplies has caused worsening road conditions at Port Fourchon. While local governments near the service bases have gained revenue from the increased activity within their jurisdictions, the demands for additional services and facilities resulting from oil and gas operations have sometimes exceeded growth in the revenue stream. Local tax dollars cannot meet the many demands for improvements when they are needed in short timeframes. State and Federal matching funds are sought where possible, but the acquisition of those funds often has built-in delaying factors. Nevertheless, communities are attempting to meet the demands of the offshore industry. Thus, the oil and gas industry is determining the direction and scope of improvements being made at local levels. Communities, just like the ports, must be able to anticipate future demands for their services. In order to plan for this growth, communities need timely information about trends in the industry.

Rapidly developing offshore technology has placed an additional burden on service-base ports. As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range of travel, greater speed of travel, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: a strong and reliable transportation system; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; a location central to OCS deepwater activities; adequate worker population within commuting distance; and an insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m.

Edison Chouest, in 1996, built their C-Port facility in Fourchon, Louisiana, as a one-stop shopping service base for the offshore. This facility was described in **Chapter 3.3.5.2**. The success of the C-Port as well as recent port expansions has caused Port Fourchon to emerge as the deepwater service-base port for the OCS. Shortly after C-Port opened in 1997 it was "busting at the seams" with activity and more space was needed. C-Port 2 was constructed in three phases with the first to open in 1999 and the last completed in 2004 (DeLuca, 2005).

While some service bases only suffered minimal damage from the back-to-back storms, others did not fare so well. The Port of New Orleans and the Port of South Louisiana both were able to resume limited operations shortly after Hurricane Katrina. The Port of New Orleans suffered extensive damage, yet by the end of March 2006, approximately 70 percent of the Port of New Orleans was operational and 85 percent of workers had returned. Officials at the Port of South Louisiana assessed the damage at approximately $2 million (Louisiana Hurricane Resources, 2006). Port Fourchon suffered both wind and water damage during both hurricanes. It took on 2-8 ft of water in both hurricanes and suffered $7 million in damage. However, within a week of the storm, the port was approaching 35-45 percent of pre-Katrina activity, and after a month it was at 90 percent (Russell, 2006).

Of the ports in Louisiana that service the offshore oil and gas industry, the Ports of Venice and Cameron were the hardest hit and took the longest to return to near normal operation levels. However, as of late August 2006, all of the U.S. Gulf Coast seaports impacted by Hurricanes Katrina and Rita have returned their operations up to at or near what they were before the storms hit (Dismukes, 2006, personal communication). Although operations at Venice are nearly back to normal, as of September 2006, the surrounding community still does not have adequate housing, a grocery store, or restaurants to support the 1,500-2,000 employees that work at the port. The surrounding community in Cameron is experiencing similar problems. Hence, most companies at the port are operating as if the port were an offshore facility, providing housing and three meals a day while employees work typical offshore schedules such as 7 days on/7 days off or 14 days on/7 days off to allow for long commutes. This is resulting in increased operating costs for the service companies. In addition, the companies located at Cameron are facing increased challenges (and operating costs) as a result of sedimentation of the Cameron Loop (or Monkey Island Loop) from Hurricane Rita. Originally dredged to 26 ft, some areas are now only 12-17 ft (4-5 m) deep, severely limiting the size of ships that can safely navigate those waters (Broussard, personal communication, 2006). As a result, some companies have relocated to areas outside the Cameron Loop, while some of the companies that stayed are using smaller boats that need to make more trips to provide the same level of service. Although the companies are able to absorb the increased operating costs (and pass some portion of them on to their customers) in the current economic environment of the industry, it remains to be seen how long they can continue to operate profitably under these conditions. As a result, the port would like to get the Cameron Loop dredged, at a minimum back to the original 26 ft (8 m) and ideally to a depth of 35 ft (11 m) to allow for deepwater access to service deepwater drilling and production.

As the industry continues to evolve so do the requirements of the onshore support network. With advancements in technology, the shoreside supply network continues to be challenged to meet the needs and requirements of the industry and will be challenged in the future. All supplies must be transported from land-based facilities to marine vessels or helicopters to reach offshore destinations. This uses both water and air transportation modes. The intermodal nature of the entire operation gives ports (that traditionally have water, rail, and highway access) a natural advantage as an ideal location for onshore activities and intermodal transfer points. Therefore, ports will continue to be a vital factor in the total process and must incorporate the needs of the offshore oil and gas industry into their planning and development efforts, particularly with regard to determining their future investment needs. In this manner, both technical and economic determinants influence the dynamics of port development.

The following are profiles of three ports that are significantly involved in offshore support. These profiles are representative of OCS supply/crew bases. An effort has been made to describe their operational structure as well as to describe their facilities and equipment. However, to continue to offer a viable service and to stay current with technological trends and industry standards, ports must be able to incorporate offshore oil and gas trends into their planning for future infrastructure development, staffing needs, and other impacts associated with rapid industrial growth.

Morgan City, Louisiana

The Port of Morgan City is located within the community of Morgan City in St. Mary Parish, Louisiana. With immediate access to I-49, it is 1 hr away from New Orleans, Lafayette, and Baton Rouge. Two thousand linear feet of rail spur and 1,500 linear feet of sidings connect the port warehouses with Burlington Northern mainline. Daily rail service is provided by Burlington Northern. The port was created in 1952. Since 1957, it has been active in both domestic and international trade. It is governed by a nine-member Board of Commissioners, who are appointed by the Governor and serve for a nine-year term. Morgan City is the only medium draft harbor between New Orleans and Houston on the Gulf. Its 400-ft wide channel is maintained by the U.S. Army Corps of Engineers to a constant depth of 20 ft (EconSouth, 2004). Its docking and cargo handling facilities serve a wide variety of medium draft vessels.

Centrally located along the Gulf Coast, the port is only 18 mi from the open waters of the GOM at the intersection of the Gulf Intracoastal Waterway (GIWW) and the Atchafalaya River. It is on the east bank of the Atchafalaya River in a natural wide and deep harbor known as Berwick Bay. The Atchafalaya River, the GIWW, and Bayous Boeuf, Black, and Chene are the connections to traffic throughout the continental U.S. and abroad. The Atchafalaya River has its beginnings at the junction of Old River and the Red River in east-central Louisiana. Old River is a short connection between the head of the Atchafalaya and the Mississippi Rivers. The Atchafalaya River flows southward a distance of 135 mi and empties into the Atchafalaya Bay. Traffic between points in the southwest U.S. and the Upper Mississippi River Valley saves approximately 342 mi per round trip by using the Atchafalaya River rather than the alternate link of the GIWW via the Harvey Locks at New Orleans.

The port is suitable to handle container, general, and bulk cargo. There are over 200 private dock facilities located in the Morgan City vicinity, most of which are oil and gas related. The port's facilities include heavy-lift, barge-mounted cranes with capacities to 5,000 tons, track cranes to 300 tons, and mobile cranes to 150 tons (Port of Morgan City, 2006a). Its facilities include an 800-ft dock, a 20,000 ft^2 warehouse with rail access, a large marshalling yard, a 50-ton capacity mobile track crane, and a 40-ton, top-lift container stacker (Port of Morgan City, 2006b).

Port Fourchon, Louisiana

Port Fourchon, Louisiana, is located at the mouth of Bayou Lafourche where it empties into the GOM. It is approximately 60 mi south of New Orleans. Its easy accessibility from any area in the GOM has made it one of the most active oil and gas ports on the coast. Port Fourchon's location at the end of LA Hwy 1 is in the center of one of the richest and most rapidly developing industrial areas of the Gulf region. While the growth of other ports has slowed, Port Fourchon has been expanding to meet the changing needs of the offshore oil-field industry. Port Fourchon has been designated as one of Louisiana's Enterprise Zones and therefore offers many tax advantages. Its close proximity to the GOM, along with its planned development and multidimensional services, make Port Fourchon one of the most significant oil and gas ports on the Gulf Coast.

The development and supervision of Port Fourchon is under the authority of the Board of Commissioners of the Greater Lafourche Port Commission (GLPC) with headquarters in Galliano, Louisiana. The Commission is composed of nine members who are elected to serve six-year terms. Established in 1960, the GLPC Board is the only elected port authority in Louisiana and its members must be at least 21 years of age and residents of the 10th Ward of Lafourche Parish, Louisiana. The Commission regulates commerce and vessel traffic within the Port Fourchon area, owns land and lease facilities, establishes 24-hr law enforcement through its Harbor Police Division, maintains paved roads, and provides facilities for governmental coordination such as the U.S. Customs Service and U.S. Coast Guard. Over its 50-year history, the GLPC has cultivated opportunities for businesses and steady economic growth for Port Fourchon and the surrounding area.

Port Fourchon is a multiuse port primarily servicing the needs of oil and gas development. Major tenants of the port include companies that provide logistics support, drilling fluids, food services, rig repair and construction, and helicopter transportation. Over 95 percent of tonnage handled at the Port is oil and gas related. The port also serves as the land base for the Louisiana Offshore Oil Port (LOOP). Other uses include commercial fishing, recreation, and shipping (Greater Lafourche Port Commission, 2006a).

Port Fourchon has become the primary service base for OCS deepwater drilling. The port currently serves over 75 percent of the GOM's deepwater oil production (Greater Lafourche Port Commission, 2006b). Its location gives it an unparalleled advantage in that it is farther south than any other base in Louisiana. And, with a channel depth of 23 ft and width of 300 ft, the port attracts a substantial amount of drilling rig repair and refurbishing business. Today the port is comprised of nearly 1,300 ac (Paganie, 2006a). To respond to the increased developments in deepwater drilling, the port has been expanding. Construction began in 2001 on Phase 1 of the Northern Expansion area. Phase 1 is a 700-ac site with 21,000 linear feet of water frontage, 700-ft wide slips, and a major rig repair facility. Further expansion plans are for Fourchon Island. Plans include dredging a 50-ft channel to extend 6.5 mi into open waters to further accommodate rig repair and refurbishment. The port has grown at a phenomenal rate because of the growth in the oil and gas industry and its development in the deepwater areas of the GOM

(Paganie, 2006a; Greater Lafourche Port Commission, 2006c). Specifically, the port has grown from 2 to 160 companies in the past two decades. Most of that growth has occurred since 1995 when the Port was less than one-third of its current size (Louisiana Sea Grant, 2006b).

The port is connected to the GIWW via Bayou Lafourche, the Houma Navigation Canal, and the Barataria Waterway. The port also houses a large number of docks with crane service, loading/unloading equipment, warehouses, refrigerated warehouse, and numerous storage yards. Improved and unimproved property is available.

While location on the GOM is an advantage to Port Fourchon, the flood-prone, 2-lane LA Hwy 1 is a major impediment for the port. However, the Louisiana Department of Transportation and Development is preparing design and rights-of-way acquisition plans for the construction of a 17-mi elevated 4-lane highway from Golden Meadow to Port Fourchon. The new highway is expected to open in January 2008 (Paganie, 2006a).

Port Fourchon serves a significant portion of the GOM offshore oil and gas industry. And, after the hurricane damages to the ports of Cameron and Venice, this share increased dramatically. "Rather than highlighting the port's vulnerabilities, Hurricane Katrina elevated Port Fourchon's importance. The port took a relatively small blow from both Hurricanes Katrina and Rita. But the two storms severely hit Louisiana energy ports in Venice and Cameron, forcing service companies there to relocate to Port Fourchon" (Russell, 2006). Although other ports are open and accessible, such as Morgan City, Galveston, or New Orleans, Port Fourchon provides the only port in Louisiana with direct access to the GOM. **Chapter 3.3.5.2** also discusses the port and its conditions, including hurricane impacts.

Port of Mobile, Alabama

With its deepwater seaport facilities at the Port of Mobile, the Alabama State Docks is conveniently located on the Central GOM. It is closer to open water than any other major port on the Gulf. Although, there has been commerce in and out of the Port of Mobile since the early part of the 17th century, it was not until 1826 that the U.S. Congress authorized money for the development of a navigable channel in Mobile Bay. The current navigation channel, maintained by the U.S. Army Corps of Engineers, provides a navigational depth of 45 ft from the GOM to the mouth of the Mobile River. Four trunkline railroads (Burlington Northern/Santa Fe, CSX, Illinois Central, and Norfolk Southern) serve the port, which is situated at the intersection of two major interstate highways. The State offers 1,500 mi of navigable inland barge routes and is served by the Tennessee-Tombigbee Waterway, which connects 16,000 mi of interstate barge lanes with the Port of Mobile.

For the first 200 years of its existence, the Port of Mobile did not have a central organization to guide the development and operation of the port. In 1922 the State Docks Commission was established with the power to build, operate, and maintain wharves, piers, docks, quays, grain elevators, cotton compresses, warehouses, and other water and rail terminals, structures, and facilities. Since that time, the Alabama State Docks have been a part of Alabama State government and functions as an independent department with a board of directors. Today, the Department operates as a self-supporting enterprise agency of the Executive branch of State government.

In 2004, the economic impact to the State of Alabama was over $3 billion statewide. Tax payments of $467 million were made from activities in the international trade sector. And most importantly, the Alabama State Docks supports the jobs of more than 118,000 Alabamians (Alabama State Port Authority, 2006a).

The port offers 27 general cargo berths where ships can load to a draft of 40 ft. Berth 2 at the southern end of the main complex has a newly paved 16-ac container yard. Located in the Theodore industrial complex on Mobile Bay at the entrance of Theodore Ship Channel is the Mobile Middle Bay Port, comprised of 13 new buildings and 200 ac of prime waterfront property. The property has a two-sided, 600-ft pier and offers more than 240,000 ft^2 of covered space on a 40-ft channel depth. And, on the turning basin of Theodore Ship Channel, a new Marine Liquid Bulk Terminal was dedicated in May 2000. It has a 1,100-ft pier that can accommodate ships up to 850 ft in length with 125-ft beam and a 400-ft or two 300-ft barges. The terminal is capable of allowing four vessels to dock at one time because of its pier jetty design. A major safety feature is a laser approach monitoring system, allowing pilots to better monitor speed and angle for a safer vessel docking (Alabama State Port Authority, 2006b).

3.3.5.8.2. Navigation Channels

The analysis performed to identify current OCS service bases (**Chapter 3.3.5.8.1**, Services Bases) was also used to identify relevant navigation waterways that support OCS activities. **Table 3-36** identifies the waterways and their maintained depth, while **Figure 3-17** shows their locations throughout the analysis area. In addition to OCS activities, navigation waterways also attract recreational and commercial developments along their banks. These developments are generally dependent upon the water resources or transportation that those waterways make accessible.

3.3.5.8.3. Helicopter Hubs

Helicopter hubs or "heliports" are facilities where helicopters can land, load and offload passengers and supplies, refuel, and be serviced. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Most of the OCS-related helicopter trips originate at helicopter hubs in coastal Texas and Louisiana. There are approximately 247 heliports within the Gulf region that support OCS activities; 122 are located in Texas, 81 in Louisiana, 34 in Florida, 6 in Mississippi, and 4 in Alabama (Louis Berger Group, Inc., 2004). Three helicopter companies dominate the GOM offshore helicopter industry: Bristow Group (formerly Offshore Logistics), Era Aviation (Era), and PHI (formerly Petroleum Helicopters, Inc) (U.S. Securities and Exchange Commission, 2005a). These top three providers account for nearly 80 percent of the aircraft available in the Gulf (U.S. Securities and Exchange Commission, 2005b).

Offshore helicopter business volume is linked to drilling activity, which is, in turn, tied to the price of oil. When there is more cash flowing in the oil and gas industry, there is more drilling and therefore more helicopter trips (Craig, personal communication, 2001). As discussed in **Chapter 3.3.5.2**, because of the low price of oil ($10) during 1998-1999, the offshore oil and gas industry experienced a slowdown that resulted in a slowdown for the helicopter industry. During this time the oil and gas industry merged, consolidated, and formed alliances. And, instead of running their own fleets, many oil and gas companies contract helicopter support companies to service their offshore rigs. Therefore, during this downturn in the late 1990's helicopter services to the offshore oil and gas industry also declined. In the early 1990's, 75-80 percent of PHI's operating revenues were generated by oil and gas transportation services in the GOM (U.S. Securities and Exchange Commission, 1994). This number has declined to just 62 percent in 2004 and 60 percent in 2005 (U.S. Securities and Exchange Commission, 2005c). To balance revenues, many helicopter transportation service companies have diversified over the years. For instance, PHI also provides air medical transportation services for hospital and emergency service agencies. The share of PHI's operating revenues from these services has increased from 17 percent in 2003 to 31 percent in 2005 (U.S. Securities and Exchange Commission, 2005c).

Each of these offshore helicopter support companies depend on a small number of customers for a significant portion of their revenues. Often, contracts are entered with customer for terms of at least 1 year, and often, additions to the fleet will be covered or allocated to a specific company contract. The PHI's largest customer provides the company with 14 percent of its operating revenues (U.S. Securities and Exchange Commission, 2005c). Era Aviation's (now a division of Seacor) 10 largest customers account for 45 percent of its operating revenues (U.S. Securities and Exchange Commission, 2005c). And, 48 percent of Bristow's operating revenue comes from its top 10 customers (U.S. Securities and Exchange Commission, 2005d). The loss of any one customer could materially affect any company's operations.

The outlook for the helicopter transportation industry is favorable as prices for oil and gas climb and production in the GOM is expected to increase. The offshore helicopter business has been improving. PHI's operating revenues for 2005 were $39.5 million higher than 2004, an increase of 22 percent (U.S. Securities and Exchange Commission, 2005c). This increase is attributed to an increase in flight hours in the GOM and an increase in contracted aircraft. Deepwater drilling, which is farther offshore, is also a growth area for helicopters. In 2000, about 35 percent of PHI's business is in support of deepwater oil and gas activities. This number is expected to increase (Persinos, 2000).

To meet the demands of deepwater (travel further and faster, carry more personnel, all-weather capabilities, and the need for lower operating costs), the offshore helicopter industry is purchasing new helicopters. For example, Bristow recently acquired 15 new medium-sized helicopters from Sikorsky Aircraft Corporation. Of these 15, 6 were delivered in FY 2004, 4 in FY 2005, 2 in the first half of FY

2006 and 1 is expected in 2007. In addition, the contract with Sikorsky was amended to acquire 32 additional medium-sized helicopters between 2007 and 2013 (U.S. Securities and Exchange Commission, 2005b). The PHI also has deliveries scheduled for FY 2006 and FY 2007 for 3 additional transport category aircraft and 24 additional medium and light aircraft for service in the GOM (U.S. Securities and Exchange Commission, 2005c). The helicopters operating in the GOM have travel ranges up to 450 nmi, can attain speeds over 200 mph, carry up to 20 passengers, and may cost $10 million or more.

While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore. Air Logistics (now Bristow Group) opened a 90-ac facility in Galliano, Louisiana, in 2004. The site features more than 33,000 ft^2 of ramp area with 28 helipads to provide improved access to operations in the GOM (Kammerzell, 2004). And, in 2001, Era Aviation expanded it base in Venice, Louisiana, to take advantage of deepwater market opportunities (Sullivan, 2004; Kelly, 2006).

All three GOM dominant offshore helicopter companies saw an increase in operations and revenues in the months after Hurricanes Katrina and Rita. Bristow Group stated that current activity levels in the GOM are at or near all-time highs (U.S. Securities and Exchange Commission, 2006).

3.3.5.8.4. Construction Facilities

Unless otherwise indicated, the following information is from the 2004 MMS study, *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (Louis Berger Group, Inc., 2004).

Platform Fabrication Yards

Platforms are fabricated onshore then towed to an offshore location for installation. Facilities where platforms are fabricated are called platform-fabrication yards. Production operations at fabrication yards include cutting and welding of steel components, construction of living quarters and other structures, as well as assembling platform components. There are 43 platform fabrication yards located in the analysis area. **Table 3-38** shows the distribution of platform fabrication yards by State. Most of the yards are located in Louisiana (31). Major fabrication yards in the analysis area include Atlantic Marine, Friede Goldman, Gulf Island Fabricators, J. Ray McDermott, and Unifab International. In early 2000, platform fabrication yards were facing a difficult market with low volumes and low margins. Competition from companies within the GOM as well as overseas was causing every project to be bid very aggressively (Hull, 2002). However, as activity in the GOM has been increasing and the number of projects slated for deepwater increases, platform fabrication yards are feeling the impact (*Natural Gas Week*, 2005). One company increased its number of workforce by 250 employees after landing a contract to build two platforms. Even before the hurricanes of 2005, fabrication yards were already busier than the previous year (*Natural Gas Week*, 2005).

The location of platform fabrication yards is tied to the availability of a navigable channel sufficiently large to allow for towing of bulky and long structures such as offshore drilling and production platforms. Thus, platform fabrication yards are located either directly on the coast of the GOM or inland, along large navigable channels, such as the Intracoastal Waterway. Average bulkhead depth for water access for fabrication yards in the Gulf is 15-20 ft (*Offshore*, 2000). Most fabrication yards in the analysis area are located along the Intracoastal Waterway and within easy access to the GOM. At least 12 of these plants have deep channel access to their facilities, which allows them to easily handle deeper draft vessels required in deepwater.

For the most part, each yard has a specialty, whether it is the fabrication of separator or heater/treater skids, the construction of living quarters, the provision for hookup services, or the fabrication of jackets, decks, and topside modules. Few facilities have complete capabilities for all facets of offshore projects. Despite the longer-term outlook most producers take toward offshore exploration and production, activity is still closely tied to the price of oil and gas. As prices drop, supporting industries such as fabrication become less busy, often resulting in layoffs that tend to drive experienced workers to other industries.

Because of the size of the fabricated product and the need to store a large quantity of materials such as metal pipes and beams, fabrication yards typically occupy large areas, ranging from just a few acres to several hundred acres. Typical fabrication yard equipment includes lifts and cranes, various types of welding equipment, rolling mills, and sandblasting machinery. Besides large open spaces required for jacket assembly, fabrication yards also have covered warehouses and shops. Because the construction of platforms is not likely to be standardized, an assembly-line approach is unlikely and most fabrication yards work on projects one at a time. Once a platform is completed, it is towed to its offshore location; work then begins on a new platform. The number of employees varies between fabrication yards, from less than a hundred to several thousands, and because of the project-oriented type of work, temporary workers account for a significant portion of the workforce.

As mentioned, platform fabrication is not a mass production industry; every platform is custom built to meet the requirements of a specific project. This feature has given rise to a great degree of specialization in platform fabrication. No two fabrication yards are identical; most yards specialize in the fabrication of a particular type of platform or platform component. Examples of specialization include the construction of living quarters, provision of hook-up services, and fabrication of jackets and decks. According to a published survey of fabrication yards in the GOM, 23 yards fabricate jackets, 15 fabricate decks, 29 fabricate modules, 22 fabricate living quarters, and 20 fabricate control buildings (*Offshore*, 2000). Despite the specialization of these yards, most facilities do include

- steel stockyards and cutting shops that supply and shape steel;
- assembly shops that put together a variety of components such as deck sections, modules, and tanks;
- paint and sandblasting shops;
- drydocks that work on small vessels;
- piers that work on transportation equipment and the platform components that are mobile and can be transported onto barges; and
- pipe and welding shops.

Despite the large number of platform fabrication facilities in the analysis area, only a few facilities can handle large-scale fabrication. Nine yards have single-piece fabrication capacity over 100,000 tons and 12 have capacity to fabricate structures for water depths over 1,000 ft. Only a few yards fabricate structures other than fixed platforms: one fabricates compliant towers (J. Ray McDermott, Inc. in Amelia, Louisiana) and two fabricate tension-leg platforms (Gulf Island Fabrication Inc. in Houma, Louisiana, and Friede Goldman Offshore in Pascagoula, Mississippi) (*Offshore*, 2000). Another important characteristic of the industry is the high degree of interdependency and cooperation among the fabrication yards; offshore platforms, particularly the ones destined for deep water, are such complex engineering projects, most facilities do not have the technical capabilities to complete the entire project "in-house."

Over the history of its existence, the platform fabrication industry has been closely tied to the fortunes of the oil and gas industry. Drilling and production activities are sensitive to the changing prices for oil and gas. This sensitivity, in turn, is translated into "boom and bust" cycles for the fabrication industry, where a period of no work follows a period of more fabrication orders than a yard can complete. In order to shield themselves from the volatility inherent in the oil and gas industry, platform fabrication yards in the analysis area have started to implement various diversification strategies. These diversification strategies, coupled with the new challenges brought about by deepwater oil and gas exploration and development, are significantly changing the industry.

In order to use the existing equipment and to retain their highly-skilled workforce during periods of low or no fabrication orders, many fabrication yards are expanding their operations into areas such as maintenance and renovations of drilling rigs, fabrication of barges and other marine vessels, dry-docking, and surveying of equipment. These projects, although much smaller in scale and scope than platform fabrication, allow the yards to survive during low periods. Another avenue of diversification is pursuit of international platform fabrication. For example, McDermott does fabrication for offshore waters in the Far East and Middle East. Fabrication yards in the analysis area have the advantages of vast experience in fabrication work and good climatic conditions that allow for year-round operations. Fabrication companies have also developed new offshore management software and company specific systems for managing and monitoring offshore sites onshore. New and improved platforms or platform upgrades and revamps complement many of these systems and software.

The platform fabrication industry has experienced a lack of skilled workers at the beginning of an upswing in the business cycle; during the downswing the skilled labor migrates to other jobs. Having learned from past mistakes, some fabrication companies have organized technical training programs in the local communities. A locally trained workforce provides a readily available pool of skilled labor for the fabrication yards. Other companies have found a solution to the workforce problem through the acquisition of several individual fabrication yards located within the commuting area. This allows companies to dispatch their personnel to several yards to accommodate the existing need at any given time.

The back-to-back hurricanes, Katrina and Rita, significantly increased the workload for platform fabricators as many struggled to get back on their feet and repair damage to their own facilities (Petroleum Intelligence Weekly, 2005). While some suffered minimal damage, others were shut down for weeks. Not only were platform fabricators' facilities flooded or damaged, but so were their employees' homes. The labor market for fabrication yards has historically been tight, and the hurricanes increased the shortage of both skilled and unskilled laborers. One fabrication company noted that FEMA has allowed contractors to pay significantly higher wages than normal for the area, only making the labor situation worse (Gulf Island Fabrication Inc., 2005). In addition, the hurricanes increased the levels of silt in navigational channels, causing water depths to delay operations (Guillet, 2006).

While many facilities experienced a variety of damages during the 2005 hurricane season, this damage appears to be short-run in nature, lasting only several weeks and at best through the end of 2005. There are no current reports of any facilities being permanently damaged or taken out of service for any extended period of time. Current industry reports indicate that all platform fabrication facilities are operational. Further, no trade associations have reported any permanent outages, damages, or ongoing negative implications created by the hurricanes of 2005. This includes the Offshore Marine Service Association, the Shipbuilders Council of America, the National Ocean Industries Association, and the International Association of Drilling Contractors.

Because the hurricanes caused significant damage to existing fields and platforms, the focus for fabricators and their customers is getting production back online. New construction activities may be delayed until repairs to existing structures are completed. However, with high oil and gas prices leading to increased exploratory drilling, especially in deep water, and new LNG projects beginning to materialize, platform fabricators are expected to remain busy for the remainder of 2006 and 2007 (Gulf Island Fabrication Inc., 2005).

Labor issues have been an issue for the industry for several years, particularly in skilled trades like welding. However, at the current time, there are no reports or indications from the trade press, industry, or trade associations that any worsening of these labor issues as a result of the 2005 tropical activity will be permanent or even long term.

Generally, most industry forecasts are positive for all service, support, and equipment manufacturing in the industry. Demand for services and equipment from this sector, including general maintenance and platforms, ships, and other offshore support structures and vessels is strong. Tight markets have allowed this sector of the industry to significantly increase charges to energy companies developing, and reworking, facilities in the GOM.

Pipecoating Plants and Yards

Pipecoating plants generally do not manufacture or supply pipe. They receive the manufactured pipe by rail or water at either their plant or pipe yard depending on their inventory capabilities. At the plant, pipe surfaces are coated with metallic, inorganic, and organic materials to protect from corrosion and abrasion. This process also adds weight to counteract buoyancy. Sometimes the inside of the pipe is also coated for corrosion control. Two to four sections of pipe are then welded at the plant into 40-ft segments. The coated pipe is stored (stacked) at the pipe yard until it is needed offshore. It is then placed on barges or layships where the pipeline contractor welds the 40-ft sections together and cleans and coats the newly welded joints. Finally, the pipe is laid.

There are 19 pipecoating plants in the analysis area (**Table 3-38**). Twelve of the 19 plants are located in EIA's TX-2 and LA-2. There are two pipecoating plants in the Mississippi-Alabama area, two in the Florida Panhandle area, and one near Tampa, Florida. To meet deepwater demand, pipecoating companies have been expanding capacity or building new plants. Major pipecoating companies in the analysis area are Bayou, Bredaro Price, and Womble. Many pipecoating plants also handle pipe for non-OCS companies, other countries, and non-petroleum-related industries.

The pipecoating industry is labor intensive. The coatings are mostly applied by hand. The companies try to maintain a core base of laborers, then either scale up or down with temporary labor according to workload. Because of the cyclical nature of the business, maintaining labor is a problem for the industry. In addition, pipecoating companies compete with other infrastructure industries for welders. In order to reduce this problem, several companies have started welding training programs. Bredaro Price has brought international labor to their Mobile, Alabama, plant in an effort to bring in experience and knowledge. They were also able to hire labor from a local paper mill that closed. Safety is a big part of the pipecoating business. Bredaro Price recently added money to their Mobile plant to automate rolling pipe. This has decreased the amount of labor needed, increased the amount of skilled labor needed, and decreased the number of accidents at the plant.

Some pipecoating plants are affiliated with a mill. These are American mills that manufacture high-grade pipe with light walls that can be used in shallow water. Foreign mills, mostly in Europe and Japan, manufacture heavy-walled pipe needed for deepwater pressure. U.S. Steel in Youngstown, Ohio, currently has the capability to manufacture the thick pipe necessary for deep water, but it lacks the processing needed to heat-treat the pipe. Pipecoating customers are both exploration and production operators (direct) and pipelaying contractors (subcontracting). A new trend in the industry is single-source contracts where the pipe manufacturing, coating, welding, and laying are all under one contract. This results in a more efficient, less costly operation. At present, only foreign companies have this capability.

The Bayou Companies' facility at the Port of Iberia was submerged in 5 ft of water during Hurricane Rita. The coating plant was out of service for two weeks as a result of the storm but has returned to normal operations (Landry, 2006; Dismukes, 2006, personal communication). The storm, plus customer demand, has led to the decision to build a new facility at the Bayou Companies' site. The new plant will be 11 ft above sea level (Landry, 2006). According to Merritt Chastain at the National Association of Pipecoating Applicators, the Bayou Companies in Louisiana is really the only pipecoating applicator on the Gulf Coast that was impacted by either storm.

Shipyards

The 1980's were dismal times for the shipbuilding industry. This was brought about by a combination of factors that included lack of a comprehensive and enforced U.S. maritime policy, failure to continue funding subsidies established by the Merchant Marine Act of 1936, and the collapse of the U.S. offshore oil industry, which not only hurt the shipbuilding industry but all support industries such as small shipyards and repair yards. Approximately 120,000 jobs for shipyard workers and shipyard suppliers were lost. Realizing the need to be able to compete in the international shipbuilding market, the Federal Government implemented a number of programs to strengthen the industry. The National Shipbuilding and Shipyard Conversion Act of 1993 established a program to support the industrial base for national security objectives. And, the National Defense Authorization Act of 1994 expanded the existing Title XI Federal Ship Financing Program. The goal was to reestablish the American shipbuilding industry as an internationally competitive industry (Industry Pro, 2000).

At present, there are about 89 shipyards in the U.S. with the capability of repairing oceangoing ships greater than 400 ft in length. Only nine are capable of building large oceangoing vessels, while the rest deal mainly in repairs. Of these 89 yards, 34 are located on the Gulf Coast (USDOT, 2003). In addition to the major shipyards, there are about 2,600 other companies that build or repair other craft such as tugboats, supply boats, ferries, fishing vessels, barges, and pleasure boats. Within the analysis area, there are 94 shipyards (**Table 3-38**). Major shipyards in the analysis area include Bender Shipbuilding and Repair Company (Mobile, Alabama); Northrop Grumman Ship Systems (Avondale, Louisiana; Pascagoula, Mississippi); Signal International (Pascagoula, Louisiana; Port Arthur and Orange, Texas); VT-Halter (Pascagoula and Moss Point, Mississippi); and Bollinger (New Orleans, Sulphur, and Lockport, Louisiana; Texas City, Texas) (USDOT, 2003).

The American Shipbuilding Association is the professional organization for those in the industry who are capable of constructing mega vessels that are in excess of 400 ft in length and weigh in excess of 20,000 dead weight tonnage (DWT) (American Shipbuilding Association, 2006). For this reason, their membership consists of only six companies. Of those six, two have a presence in the GOM (American Shipbuilding Association, 2006). Both Avondale Shipyard of New Orleans, Louisiana, and Ingalls Shipyard of Pascagoula, Mississippi, have enormous capabilities and expertise in the design, construction, and repair of vessels. This highly developed level of specialized knowledge has made these two companies ideal contractors for the Nation's defense efforts. Therefore, most of the work that has been accomplished in these two yards has been for the U.S. military.

The existence of enormous commercial needs has led to the development of a very large number of boat and barge builders. These companies have directed their efforts toward the requirements of specific industries such as the offshore oil and gas industry, which is undergoing a recovery from the marked decline of the 1980's. The vessels they produce are not as large as those being built by Avondale and Ingalls. However, as the oil and gas industry has evolved and becomes more sophisticated, particularly with deepwater drilling, so too has the capability of this segment of the boat-building industry. The need for supply and other types of industry support vessels has increased. With changing technology has come the need for more sophisticated and higher capacity vessels. Many of these companies are now producing ships in the 300-ft range. Five of the six most active shipyards are still in the commercial business and all are actively pursuing further supply-vessel opportunities.

During FY 2003, the U.S. ship construction and ship repair industry invested more than $345 million in the upgrade and expansion of facilities. Much of this investment was to improve efficiency and competitiveness in the commercial shipbuilding arena. Improvements were made to update and convert shipyard facilities to be more commercially viable. Examples of recent capital investments are new pipe and fabrication shops, drydock extensions, military work enhancement programs, automated steel process buildings, and expanded design programs. Many of these improvements have been necessary because of the increased use of U.S. shipyards, particularly those along the Gulf Coast, resulting from the resurgence of the offshore oil and gas industry (USDOT, 2003).

The 2005 hurricanes put an additional premium on offshore supply boats. At present, the offshore drilling industry is extremely strong, and rig supply is extremely tight as is the supply of offshore service vessels. Strong demand in the GOM and the need to replace old equipment has led several operators to announce significant vessel construction programs (Greenberg, 2006b).

The hurricanes of 2005 put an additional premium on offshore supply boats. Five of the six most active shipyards are still in the commercial business and all are actively pursuing further supply-vessel opportunities.

For example, Tidewater Inc., (New Orleans, Louisiana) has 5 supply vessels and a fast-supply boat under construction; Rigdon (Houston, Texas) ordered 10 platform-supply vessels (PSV) being built at Bollinger Shipyards in Lockport, Louisiana; and Edison Chouest (Galliano, Louisiana) will expand its Gulf fleet with 3 AHTS vessels, 10 new PSV's and 9 fast-supply vessels (Greenberg, 2006b). According to one construction survey, there were 36 supply boats on order in 2004 and 25 in 2005 (Hocke, 2006). As of June 2006, shipyards along the Gulf Coast are booked solid with at least 37 new offshore supply vessels being built. This, in addition to remaining hurricane-related repair projects, has kept the shipyards operating at full capacity (Greenberg and Krapf, 2006). In fact, it is becoming difficult to find slots for new construction, and some boat operators have been forced to look outside the GOM for shipyard capacity (Greenberg, 2006b). The damaged rigs and platforms in the Gulf as a result of the hurricanes of 2005 created a great need for shipbuilding services. However, a number of shipyards were severely damaged. While some yards, such as Austal USA in Mobile, Alabama, and Conrad Industries in Morgan City, Louisiana, sustained only minor damage, other yards such as Northrop Grumman in Pascagoula, Mississippi, and New Orleans; Bollinger Shipyards in Lockport, Louisiana, reported significant damage (Maine Log, November 2005). VT Halter Marine suffered water and wind damage at all three of its Mississippi locations (Dupont et al., 2005). The physical damages to the facilities have been repaired and they are at or near normal conditions (Dismukes, 2006, personal communication).

However, severe labor shortages caused even more problems than the physical damage for some GOM area shipyards. A large number of the shipyards' skilled labor force was displaced by Hurricane Katrina. Even two months after the storm, a number of companies remained shuttered for the sole reason that their employees did not have housing (Carr, 2005). In late 2005, Northrop was still hiring at all of its facilities along the Gulf Coast. The Company did not expect 1,500-2,000 of its employees to return at all (*Inside the Navy*, 2005). In November, Bollinger Shipyards actually had to back out of a $700 million contract and pass on another $150 million contract because high wages and scarce employees threatened the company's ability to make a profit (White, 2006). The labor shortage also forced the Navy to make an adjustment to its contract with Northrop Grumman and defer an order for an amphibious assault ship scheduled to be built at Northrop's Avondale yard from FY 2007 to FY 2008 (White, 2006). Labor constraints in shipyards continue to be an issue; however, it is expected that skilled workers will return along with new workers lured by the strong market outlook (Rach, 2006).

3.3.5.8.5. Processing Facilities

Unless otherwise indicated, the following information is from the 2004 MMS study, *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (Louis Berger Group, Inc., 2004).

Refineries

Petroleum is a mixture of liquid hydrocarbons formed beneath the earth's surface. Found in both gaseous and liquid form, the exact composition of these hydrocarbons varies according to locality. Crude oil is a mixture of hydrocarbon compounds and relatively small quantities of other materials such as oxygen, nitrogen, sulfur, salt, and water. Crude oil varies in color and composition from a pale yellow, low-viscosity liquid to a heavy black tar consistency. Because it is of little use in its raw state, further processing of crude oil is necessary to unlock the full potential of this resource.

A refinery is an organized arrangement of manufacturing units designed to produce physical and chemical changes to turn crude oil into petroleum products. Refineries vary in size, sophistication, and cost depending on their location, the types of crude they refine, and the products they manufacture. Because crude oil is not homogeneous (varying in color, viscosity, sulfur content, and mineral content), oil produced from different fields or geographic areas have different quality characteristics that give rise to different economic values.

In the refinery, most of the nonhydrocarbon substances are removed from crude oil, and the oil is broken down into its various components and blended into useful products. Every refinery begins with the separation of crude oil into different fractions by distillation. The fractions are further treated to convert them into mixtures of more useful saleable products by various methods such as cracking, reforming, alkylation, polymerisation, and isomerisation. These mixtures of new compounds are then separated using methods such as fractionation and solvent extraction.

Because there are various blends of different crude oils available, different configurations of refining units are used to produce a given set of products. A change in the availability of a certain type of crude oil can affect a refinery's ability to produce a particular product. For example, one important crude quality is gravity. Stated in API degrees (API^{o}), gravity is a measure of the density of the crude oil and can affect the complexity of a refinery. The higher the gravity, the lighter the crude oil and, conversely, the lower the gravity, the heavier the crude oil. A second quality measure is sulfur content. Sulfur content is usually measured in terms of the percentage of the crude's weight that is comprised by sulfur. Low-sulfur or "sweet" crudes typically have less than 0.5 percent sulfur content. Crude oil considered high sulfur or "sour" typically has over 0.5 percent sulfur content.

These two qualities are important in refining. Heavy crudes require more sophisticated processes to produce lighter, more valuable products; therefore, they are expensive to manufacture. Because of its corrosive qualities, higher sulfur content makes a crude more expensive to handle and process. In general, light crudes are more valuable, i.e., they yield more of the lighter, higher-priced products than heavy crudes. The product slate at a given refinery is determined by a combination of demand, inputs and process units available, and the fact that some products are the result (co-products) of producing other products.

In the early 1970's, the Federal Government set price controls that gave an economic advantage to refineries that had access to low-cost domestic oil. In 1975, the "Crude Oil Entitlements Program" was implemented to distribute oil supplies among refiners. This program basically provided a subsidy to small refining companies, many of which had simple "topping" facilities and little or no downstream processing capability. (A simple "topping" refinery will have a distillation tower and possibly a reformer and some sulfur treating capability, while complex refineries will have more extensive downstream facilities.) A refiner who had access to light crude oils needed only a distillation tower to produce motor gasoline. Therefore, many simple refineries sprang up across the country, most notably in the analysis area.

In the early 1980's, the Crude Oil Entitlements Program ended and crude oil prices were no longer controlled. This caused the number of petroleum refineries to drop sharply, leading to 13 years of decline in U.S. refining capacity. Between 1981 and 1989, the reduction in the number of refineries from 324 to 204 represented a loss of 3 MMbbl/day in operable capacity. Another 41 refineries (mainly small) shut down between 1990 and 1997. Since the 1980's, the refining industry's focus has turned from increasing crude oil distillation capacity to investment in downstream charge capacity, thereby increasing overall refinery complexity. This transition began several years before the passage of the Clean Air Act Amendments in 1990 as a result of increased demand for lighter, cleaner products that have to be produced from increasingly heavier and more-sour crude oils.

The 1990's was characterized by low product margins and low profitability. Stiff environmental mandates, stemming from 1990 amendments to the Clean Air Act, increased capital costs on the industry at a time of relatively flat product demand. By implementing massive capital spending programs, refiners met and surpassed plant emission goals while retooling to produce a new generation of cleaner burning fuels. Low profitability was also partially because of the narrowing of the spread between petroleum product prices and raw material input costs. Additionally, persistently low profits prompted domestic refiners and marketers to make concerted efforts to realize greater value from their fixed assets and to reduce their operating costs. Refining operations were consolidated, the capacity of existing facilities was expanded, and several refineries were closed.

One-third of operable U.S. petroleum refineries are located in the Gulf States of Alabama, Louisiana, Mississippi, and Texas. Most of the region's refineries are located in Texas and Louisiana (**Table 3-38**). Texas has 25 operating refineries, with a combined crude oil capacity of 4.6 MMbbl/day, while Louisiana has 17 operating refineries with 2.8 MMbbl/day of capacity, representing 27.2 and 16.3 percent, respectively, of total operating U.S. refining capacity (USDOE, EIA, 2005c).

Most refineries are part of major, vertically integrated oil companies that are engaged in both upstream and downstream aspects of the petroleum industry. These companies dominate the refining industry. A wave of mergers in the 1990's and recent years has further consolidated the downstream petroleum industry. The top 10 U.S. refiners in 1993 accounted for almost 56 percent of the market (Public Citizen, 2004). Today, the top 10 U.S. refiners, most all of them major, integrated oil companies, account for 75 percent of the total domestic refinery operating capacity (USDOE, Office of Electricity Delivery and Energy Reliability, 2005b; USDOE, EIA, 2005d).

One of the largest joint ventures affecting U.S. refining and marketing was announced in two parts in 1997. The first venture, known as Equilon Enterprises, combined the Midwestern and western operations of Shell Oil and Texaco. This included eight refineries and related assets (USDOE, EIA, 2006c). The second venture merged the eastern and Gulf Coast operations of Shell Oil (the U.S. subsidiary of Royal Dutch/Shell) and Star Enterprise (a joint venture between Texaco and Aramco, the Saudi Arabian state oil company). The venture, known as Motiva Enterprises, LLC included a total of four refineries (USDOE, EIA, 2006c).

Later, in October 2000, Chevron and Texaco agreed to merge. However, the FTC set a major condition when approving the October 2001 merger. Texaco had to sell its shares of the Equilon and Motiva Enterprises. The FTC allowed Shell to purchase 100 percent of Equilon, and Shell and Aramco bought out Texaco's share of Motiva (USDOE, EIA, 2006c; Public Citizen, 2004).

Significant mergers have also occurred between independent refiners and marketers. However, unlike the major U.S. petroleum companies, which are consolidating their refining and marketing operations through joint ventures, the independent refiners and marketers are expanding their operations through mergers and, at least in one case, joint ventures. For example, in 1997 Ultramar Diamond Shamrock (itself created by a late 1996 merger) acquired Total Petroleum North America, gaining three refineries, more than 2,100 marketing outlets, and hundreds of miles of pipelines, in addition to other associated assets (USDOE, EIA, 2006d). More recently, in 2005, Valero Energy agreed to acquire Premcor Inc. This transaction transforms the fourth (Valero) and eighth (Premcor) largest refiners into the second-largest, and largest nonvertically integrated domestic refiners (USDOE, EIA, 2006b).

Thirty-three of the Gulf Coast's 40 operating refineries were impacted by the hurricanes and 9 sustained damage (6 of Louisiana's 17, 2 of Texas' 17, and 1 of Mississippi's 4). These damaged facilities resulted in a total loss of capacity of 2.3 MMbbl/day, which represented 31 percent of GOM refining capacity and 13 percent of U.S. operating capacity (USDOE, EIA, 2005c; USDOE, Office of

Electricity Delivery and Energy Reliability, 2005a-d). In addition, facilities that did not sustain direct damage were impacted by supply interruptions.

Virtually all refineries impacted by the 2005 hurricanes are back up and running at capacity levels that existed before the storms. As of May 2006, two refineries – BP's Texas City, Texas, refinery and ConocoPhillip's Belle Chasse, Louisiana, refinery – had just returned to service (USDOE, EIA, 2006e). Murphy's Meraux refinery is expected to come online in the second quarter of 2006 (USDOE, EIA, 2006f). The last plant to come online, Murphy Oil's Meraux plant in Meraux, Louisiana, has a capacity of 125,000 BOPD. The plant came back online in early May 2006 and had reached 100,000 b/d of throughput in mid-June. It was slated to be at full capacity by June 30; however, a company statement dated July 25 said the plant is still "nearing normal operations" (Norman, 2006).

Petrochemical Plants

The chemical industry converts raw materials such as oil, natural gas, air, water, metals, and minerals into more than 70,000 different products. The non-fuel components derived from crude oil and natural gas are known as petrochemicals. Petroleum is composed mostly of hydrogen and carbon compounds (called hydrocarbons). It also contains nitrogen and sulfur, and all four of these components are valuable in the manufacture of chemicals.

The industrial organic chemical sector includes thousands of chemicals and hundreds of processes. In general, a set of building blocks (feedstocks) is combined in a series of reaction steps to produce both intermediate and end products. The processes of importance in petrochemical manufacturing are distillation, solvent extraction, crystallization, absorption, adsorption, cracking, reforming, alkylation, isomerization, and polymerization.

The boundaries of the petrochemical industry are rather unclear. On the upstream end, they blend into the petroleum refining sector, which furnishes a major share of petrochemical feedstocks; downstream it is often impossible to draw a clear line between petrochemical manufacturing and other organic chemistry-based industries such as plastics, synthetic fibers, agricultural chemicals, paints and resins, and pharmaceuticals. Operating in this field are petroleum companies who have broadened their interests into chemicals, chemical companies who buy raw petroleum materials, and joint ventures between chemical and petroleum companies.

Texas, Louisiana, New York, California, and Pennsylvania are the top U.S. chemical producers in terms of value of shipments (USDOC, Bureau of the Census, 2006a). However, most of the basic chemical production is concentrated in the analysis area, where petroleum and natural gas feedstocks are available from refineries. Over 90 percent of primary petrochemical capacity (as measured by ethylene production) is located in Texas and Louisiana (Federal Reserve Bank of Dallas, 2005). At present, there are 55 petrochemical establishments in the U.S., 29 of which are in Texas and Louisiana (USDOC, Bureau of the Census, 2006a). The distribution of these plants by state is shown in **Table 3-38**.

Chemical manufacturing facility sites are typically chosen for their access to raw materials and to transportation routes. And, because the chemical industry is its own best customer, facilities tend to cluster near such end-users. A small number of very large facilities account for the majority of the industry's value of shipments. The top 5 percent of plants (there are 644 plants with more than 250 employees) manufacture over 50 percent of the total value of shipments (USDOC, Bureau of the Census, 2005b).

Laid out like industrial parks, most petrochemical complexes include plants that manufacture any combination of primary, intermediate, and end-use products. Changes in market conditions and technologies are reflected over time in the changing product slates of petrochemical complexes. In general, petrochemical plants are designed to attain the cheapest manufacturing costs and thus are highly synergistic. Product slates and system designs are carefully coordinated to optimize the use of chemical by-products and to use heat and power efficiently.

The transformation of raw materials into chemical products requires chemical, physical, and biological separation and synthesis processes. These processes use large amounts of energy for heating, cooling, or electrical power. The industry is the single largest consumer of natural gas (over 10% of the domestic total) and uses virtually all the liquefied petroleum gas (LPG) consumed in U.S. manufacturing. Other energy sources include by-products produced onsite, hot water, and purchased steam. Physical and biological separation plays a critical role in processing and accounts for 40-70 percent of both capital and operating costs (USDOE, EIA, 2006g). The most widely used separation process is distillation, which accounts for as much as 40 percent of the industry's energy use. Chemical synthesis is the backbone of the industry; process heat is integral and supports nearly all chemical operations (USDOE, EIA, 2006g).

As a result of Hurricane Katrina, many chemical firms suffered severe flooding and power outages, including Dow in St. Charles and Plaquemine, Louisiana, and DuPont at its titanium dioxide plant in DeLisle, Mississippi (Reisch and Tullo, 2005). Hurricane Rita forced shutdowns of ethylene plants throughout Texas and Louisiana coastal areas. Six ethylene plants in Beaumont and Port Arthur, Texas, and two plants in Lake Charles, Louisiana, were without power for at least 1-2 weeks in October 2005 (Lippe, 2005). For facilities that were not damaged or that sustained minimal damage, the strain on the oil and gas supply kept a number of chemical plants on partial or complete shutdown (FERC, 2005). The *Oil and Gas Journal* reported in July that any remaining hurricane-related repairs were completed in the first quarter of 2006 and currently there are no reports of any remaining damages or shutdowns (Lippe, 2006).

Gas Processing Plants

After raw gas is brought to the earth's surface, it is processed at a gas processing plant to remove impurities such as water, carbon dioxide, sulfur, and inert gases, and it is transformed into a sellable, useful energy source. It is then moved into a pipeline system for transportation to an area where it is sold. Because natural gas reserves are not evenly spaced across the continent, an efficient, reliable gas transportation system is essential. At present, there are 249 gas processing plants in the Gulf States, representing 58 percent of U.S. gas processing capacity (USDOE, EIA, 2006h). The distribution of these plants by state is shown in **Table 3-38**. Major operators include BP, Exxon, Dynergy, Duke Energy, and El Paso.

Natural gas is found below the earth's surface in three principal forms: associated gas, nonassociated gas, and gas condensate. Associated gas is found in crude oil reservoirs, either dissolved in the crude oil, or combined with crude oil deposits. This gas is produced from oil wells along with the crude and is separated from the oil at the head of the well. Nonassociated gas is found in reservoirs separate from crude oil; its production is not a result of the production of crude oil. It is commonly called "gas-well gas" or "dry gas." In 2004 about 75 percent of U.S. wellhead natural gas production was nonassociated gas (USDOE, EIA, 2006h). Gas condensate is a hydrocarbon that is neither true gas nor true liquid. It is not a gas because of its high density, and it is not a liquid because no surface boundary exists between gas and liquid. Gas condensate reservoirs are usually deeper and have higher pressures, which pose special problems in the production, processing, and recycling of the gas for maintenance of reservoir pressure.

The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. Although there is not a "typical" makeup of natural gas, it is primarily composed of methane (the lightest hydrocarbon component) and ethane. In general, there are four types of natural gas: wet, dry, sweet, and sour. Wet gas contains some of the heavier hydrocarbon molecules and water vapor. When the gas reaches the earth's surface, a certain amount of liquid is formed. A wet gas may contain five or more gallons of recoverable hydrocarbons per thousand cubic feet; the water has no value. If the gas does not contain enough of the heavier hydrocarbon molecules to form a liquid at the surface, it is a dry gas. Sweet gas has very low concentrations of sulfur compounds, while sour gas contains excessive amounts of sulfur and an offensive odor. Sour gas can be harmful to breathe or even fatal.

Centrally located to serve different fields, natural-gas processing plants have two main purposes: (1) remove essentially all impurities from the gas and (2) separate the gas into its useful components for eventual distribution to consumers. The modern gas-processing industry uses a variety of sophisticated processes to treat natural gas and extract natural-gas liquids from the gas stream. The two most important extraction processes are the absorption and cryogenic expander process. Together, these processes account for an estimated 90 percent of total natural-gas liquids production (NaturalGas.Org, 2006b).

More than half of the current natural gas processing plant capacity in the U.S. is located convenient to Federal offshore, Texas and Louisiana. Four of the largest capacity natural gas processing/treatment plants are found in Louisiana while the greatest number of individual natural gas plants is located in Texas. Louisiana continues to lead the U.S. states in processing capacity, followed closely by Texas.

Between them, the two states hold more than 53 percent of the nation's natural gas processing capacity (USDOE, EIA, 2006h).

Over the past 10 years, the number of gas processing plants in the U.S. has decreased from 727 in 1995 to 530 in 1994. However, average daily processing capacity has increased by 49 percent. In Texas, the number of plants and overall processing capacity has decreased, but the average capacity per plant has increased from 66 MMcf/d to 95 MMcf/d as newer plants were added and old, less efficient plants were idled. In Alabama, Mississippi and the eastern portion of South Louisiana, new larger plants and plant expansions built to serve new offshore production increased the average plant capacity significantly (USDOE, EIA, 2006h).

Although Texas and Louisiana still account for the larger portion of U.S. natural gas plant processing capability, other States have moved up in the rankings somewhat during the past 10 years as new trends in natural gas production and processing have come into play. Most of these plants are located in five other states: Oklahoma, Wyoming, Colorado, New Mexico, and California. These states account for 37 percent of the natural gas processing facilities and 28 percent of capacity (USDOE, EIA, 2006h).

The hurricanes of 2005 initially shut down 13.5 billion cubic feet per day (Bcf/d) of the Gulf Coast's capacity for gas processing (11.7 Bcf/d of Louisiana's capacity, 1.8 Bcf/d of Alabama and Mississippi's capacity). This represents 66.5 percent of the Gulf States' processing capacity (Lippe, 2005).

Gas processing station outages in the aftermath of Hurricane Katrina proved to be a significant constraint to offshore production restoration activities since facilities that were ready to come online could not send production to shore for processing given the outages. These facilities would have to wait weeks in order for facilities to start limited restoration and to by-pass the constrained facilities and reroute production to other onshore areas.

As of March 8, 2006, 45 of the 47 gas processing plants along the Gulf Coast were restored to active status. The final reactivation of a major processing plant occurred on April 2, 2006, when the Stingray plant resumed processing, bringing capacity of all major active plants to 1,891,000 Mcf/d (USDOE, Office of Electricity Delivery and Energy Reliability, 2006). Only one facility (BP's Grand Chenier) has been permanently shut down as result of the 2006 hurricanes. Most facilities operating along the GOM were at a 50 percent or less utilization factor prior to the storms; thus, there is spare capacity to service the processing markets (USDOE, Office of Electricity Delivery and Energy Reliability, 2006; Dismukes, 2006).

3.3.5.8.6. Terminals

3.3.5.8.6.1. Pipeline Shore Facilities

The term "pipeline shore facility" is a broad term describing the onshore location where the first stage of processing occurs for OCS pipelines carrying different combinations of oil, condensate, gas, and produced water. These facilities may also be referred to as a separation or field facilities. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to a gas processing plant (**Chapter 3.3.5.8.4**). Although in some cases some processing occurs offshore at the platform, only onshore facilities are addressed in this section.

Pipeline shore facilities may separate, process, pump, meter, and store oil, water, and gas depending on the quality of the resource carried by the pipeline. After processing and metering, the liquids are either piped or barged to refineries or storage facilities. The gas is piped to a gas processing plant for further refinement, if necessary; otherwise it is transported via transmission lines for distribution to commercial consumers. Water that has been separated out is usually disposed into onsite injection wells.

A pipeline shore facility may support one or several pipelines. Typical facilities occupy 2-25 ha (5-62 ac). The distribution of existing pipeline shore facilities associated with the OCS Program are given in **Table 3-38** and are shown on **Figures 3-13 through 3-15**.

3.3.5.8.6.2. Barge Terminals

Barge terminals are the receiving stations where oil is first offloaded from barges transporting oil from OCS platforms (**Chapter 3.3.5.7.2.2**). These facilities usually have some storage capabilities and processing facilities. Some barge terminals may also serve as pipeline shore facilities (**Chapter 3.3.5.8.6.1**).

Most of the land required at a barge terminal is for storage tanks. Space requirements range from 6 to 25 ha (15-62 ac) (NERBC, 1976).

Because the volumes of oil reported to MMS are determined at the offshore locations prior to barging, the final destination of the oil varies. Therefore, MMS does not have an exact number of onshore terminals receiving OCS oil production. Several barge terminals located along the Gulf Coast receive State production or imports. Barged OCS production may be taken to any existing barge terminal. Historically, the OCS oil industry has used the following barge terminals: Matagorda Island, Texas City, Beaumont and Nederland, Texas; and Amelia, Lake Charles, Gibson, Calumet and Empire, Louisiana. These barge terminals may also receive oil from State production or imports.

3.3.5.8.7. Disposal and Storage Facilities for Offshore Operations

Unless otherwise indicated, the following information is from the 2004 MMS study, *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (Louis Berger Group, Inc., 2004).

The infrastructure network needed to manage the spectrum of waste generated by OCS exploration and production activities and returned to land for management can be divided into three categories:

(1) transfer facilities at ports, where the waste is transferred from supply boats to another transportation mode, either barge or truck, toward a final point of disposition;

(2) special-purpose, oil-field waste management facilities, which are dedicated to handling particular types of oil-field waste; and

(3) generic waste management facilities, which receive waste from a broad spectrum of American industry, of which waste generated in the oil field is only a small part.

The first two categories lend themselves to a capacity analysis while the third does not. **Table 3-38** shows the waste disposal facilities in the analysis area by state.

The capacity of a waste facility has two dimensions. The first is the throughput capacity over a given period of time. In the short term, a waste facility can face limits to the volume of waste it accepts either from permit conditions or from physical limitations to the site, such as unloading bays, traffic conditions, or equipment capacity. Life-of-site capacity is also a limiting factor for disposal facilities. Limitations of storage space or, in the case of an injection well, service life of the well make it necessary to consider what must happen after existing facilities have exhausted their capacity.

A number of different types of waste are generated as a result of offshore exploration and production activity. The different physical and chemical characters of these wastes make certain management methods preferable over others. The types of waste include:

- solids, such as drill cuttings, pipe scale, produced sand, and other solid sediments encountered during drilling, completion, and production phases;
- aqueous fluids having relatively little solids content, such as produced waters, waters separated from a drilling mud system, clear brine completion fluids, acids used in stimulation activities, and wash waters from drilling and production operations (Although most of these are potentially dischargeable under the NPDES general permit, the possibility always exists that some amount of material will become contaminated beyond the limits of treatment capabilities and will require disposal in a land-based facility. A minute percentage of the total volume consists of chemicals (such as zinc bromide), which do not meet discharge criteria.);
- drilling muds (oil-based, synthetic, or water-based);
- naturally occurring radioactive materials (NORM), such as tank bottoms, pipe scale, and other sediments that contain naturally high levels of radioactive materials (NORM occurs in sludge and also as scale on used steel vessels and piping when

equipment has been exposed to other NORM materials after very long periods of use.);

- industrial hazardous wastes, such as solvents and certain compounds, with chemical characteristics that render them hazardous under Subtitle C of the Resource Conservation and Recovery Act (RCRA) and thus not subject to the exemption applicable to wastes generated in the drilling, production, and exploration phases of oil and gas activities;
- nonhazardous industrial oily waste streams generated by machinery operations and maintenance, such as used compressor oils, diesel fuel, and lubricating oils, as well as pipeline testing and pigging fluids (Wastes from marine transportation as well as pipeline construction and operations are always classified as industrial wastes, while some operators and State regulators may choose to handle or classify waste from drilling and production machinery this way. Used oil generated by exploration and production operations may legally be mixed with produced oil, but refineries discourage the practice. These streams often become commingled with wash water. They may be handled in drums or in bulk as part of a larger waste stream.); and
- municipal solid waste generated by the industry's personnel on offshore rigs, platforms, tankers, and workboats.

Federal regulations govern what may be discharged in GOM waters and set different standards in different parts of the Gulf Coast. **Table 3-39** summarizes current Federal rules. Wastes that cannot be discharged or injected offshore must be brought to shore. Transportation, packaging, and unloading of the waste at ports are governed by USDOT regulations while the USCG regulates vessel fitness. Once on the dock, transportation and packaging is subject to an overlay of USDOT and State laws. State regulations governing reporting and manifesting requirements may vary somewhat, but Federal law has, for the most part, preempted the field of transportation waste regulation. Dockside facilities that serve as transfer points from water to land modes of transportation are regulated by both USCG and State regulations covering the management of oil-field wastes.

Once at a waste management facility, regulations regarding storage, processing, and disposal vary depending on the type of waste. Most would fall under the oil and gas waste exemption of RCRA Subtitle C and would be subject only to State regulations regarding the disposal of oil-field wastes. A minute volume of the waste would be subject to Federal regulation as hazardous waste under RCRA Subtitle C. State laws governing hazardous wastes are allowed to be more restrictive than Federal law, but no material differences exist between State and Federal law in Texas, Louisiana, Mississippi, or Alabama. For the most part, the wastes generated by oil-field activities, called nonhazardous oil-field waste (NOW) are exempt from hazardous waste regulation by Federal law because they are produced from the exploration, development, or production of hydrocarbons and thus fall under what is generally referred to as the oil and gas waste exemption found in 40 CFR 261.

Waste fluids and solids containing NORM are subject to State regulations that require special handling and disposal techniques. There are currently no Federal regulations governing NORM. The special handling and disposal requirements for NORM generally result in the segregation of these materials from NOW and in substantially higher disposal costs when managed by commercial disposal firms.

The Railroad Commission (RRC) of Texas has jurisdiction over the handling and disposal of NORM wastes produced during the exploration and production of oil and gas. All other disposal of NORM wastes is regulated by the Texas Commission on Environmental Quality (TCEQ, 2006). The RRC regulates the disposal of oil and gas NORM under Title 16, Part 1, Chapter 4, Subchapter F, or the Texas Administrative Code. The disposal methods prohibited by Subchapter F include discharge of oil and gas NORM waste other than produced water, spreading of oil and gas NORM waste on public or private roads, and any other method that is not specifically provided for by Subchapter F (Railroad Commision of Texas, 2006a).

The disposal options for NORM-contaminated solids differ from the options for NORM-contaminated equipment. The NORM-contaminated solids, such as pipe scale, may be disposed of on the site where they were generated by burial or placement in a well that is being plugged and abandoned. Contaminated soil may be spread onto the land under certain conditions. Subchapter F also authorizes disposal of oil and gas NORM waste at a licensed facility and injection of NORM treated by a licensee provided the operator complies with specific requirements contained in the rule. The NORM-contaminated equipment that is waste, i.e., equipment that is no longer wanted, may be recycled as scrap metal or disposed of. Subchapter F does not allow the burial of NORM-contaminated equipment. Buried flowlines that contain NORM, however, may remain buried contingent on the lease agreement. The NORM-contaminated tubulars and other equipment may also be placed in a plugged and abandoned well. Equipment must be removed from a lease when the last well on the lease is plugged. All tanks, vessels, related piping, and flowlines be emptied, and requires all tanks, vessels, and related piping to be removed in 120 days (Railroad Commision of Texas, 2006a).

The State of Louisiana was the first state to develop a NORM regulatory program in 1989. This program was further enhanced by amendments in 1992 and 1995. The Louisiana Department of Environmental Quality has a comprehensive, oil-field NORM regulatory program that addresses identification, use, possession, transport, storage, transfer, decontamination, and disposal of NORM. Primary NORM regulations are in Louisiana Administrative Code 33:XV, Chapter 14: "Regulation and Licensing of NORM." Louisiana generally considers oil and natural gas well and production facilities, pipeyards, scrap yards, wood pulp processors, gas gathering stations, and rare earth chloride processing facilities to have the potential for NORM accumulation. Initial surveys are required on all potentially contaminated sites. Follow-up confirmatory surveys need to be performed whenever activities at the site could result in a possible change in regulatory status of the site.

The USEPA has established a hierarchy of waste management methods that it deems preferentially protective of the environment. For those technologies applicable to oil and gas production waste, the following general waste management techniques are described in order of USEPA's preference:

- *Recycle/Reuse*—When usable components such as oil or drilling mud can be recovered from a waste, these components are not discarded and do not burden the environment with impacts from either manufacturing or disposal.
- *Treatment/Detoxification*—When a waste cannot be recycled or reused, it can sometimes be treated to remove or detoxify a particular constituent prior to disposal. Neutralization of pH or removal of sulfides are examples of technologies that are used with oil and gas wastes.
- *Thermal Treatment/Incineration*—Wastes with organic content can be burned, resulting in a relatively small amount of residual ash that is incorporated into a product or sent to disposal. This technology results in air emissions, but the residuals are generally free of organic constituents.
- *Subsurface Land Disposal*—This technology places waste below usable drinking water resources and is viewed as superior to landfilling because of the low potential for waste migration. Injection wells and salt cavern disposal are examples of this type of technology.
- *Surface Land Disposal/Treatment*—This type of technology involves the placement of wastes into a landfill or onto a land farm. Although well-designed and constructed landfills minimize the potential for waste migration, generators remain concerned about migration of contaminants into water resources and avoid it whenever practical. The USEPA classifies surface land disposal as the least desirable disposal method.

Several waste management methods are used to handle the spectrum of wastes generated by OCS activity, and most types of wastes lend themselves to more than one method of management. Each option has a different set of environmental impacts, regulatory constraints, costs, and capacity limitations.

The U.S. oil and gas production includes an average of 10 bbl of water for each barrel of oil produced. Produced water comprises 98 percent of all waste generated by petroleum exploration and production activities (USDOE, OFE, NETL, 2005). Underground injection is the most common disposal method of produced water; over 90 percent of onshore produced water is disposed of through injection wells (USEPA, 2000).

Nonhazardous Oil-field Waste Sites

One of the largest companies operating waste facilities on the Gulf Coast is Newpark Resources, Inc. Newpark operates seven receiving and transfer facilities along the coast from Venice, Louisiana, to Corpus Christi, Texas. Waste products are collected at the transfer facilities from offshore, land, and inland waters exploration and production markets. The Company also owns a fleet of 49 double-skinned barges certified by the USCG to transport E&P waste to support these facilities. Waste received at the transfer facilities is moved by barge through the Gulf Intracoastal Waterway to a processing and transfer facility at Port Arthur, Texas, and if not recycled, it is trucked to injection disposal facilities at Fannett, Texas. Including its 400-ac site near Fannett, Texas, the company holds an inventory of approximately 1,250 ac of injection disposal property in Texas and Louisiana (Newpark, 2006a).

Newpark has been handling an increased amount of Gulf Coast waste. The number of bbl processed from the Gulf Coast has increased from 5.8 MMbbl in 2002 to 6.9 MMbbl in 2005 and a projected 7.2 MMbbl in 2006. However, Newpark's market share has been decreasing (from 66% in 2002 to 55% in 2006) (Newpark, 2006b).

One commercial salt cavern, operated by Trinity Field Services, opened near Hamshire, Texas, on the Trinity River. Four other commercial salt domes are operational in northeastern and western Texas. One commercial salt dome, Lotus, L.L.C. in Andrews County near the New Mexico border, accepts NORM, some of which comes from offshore operations. Because of their distance from the Gulf Coast, no others receive any OCS waste. With the addition of Trinity Field Services bringing 6.2 MMbbl of available space to the market, enough to take 8-10 years' worth of OCS liquids and sludges at current rates, the OCS has its first salt dome disposal operation in a competitive location (Louis Berger Group Inc., 2004).

Landfills

Workers on a rig or production platform generate the same types of waste as any other consumer in industrial society, and are therefore responsible for their fair share of municipal solid waste (MSW). A large volume of industry-specific trash also makes its way to a landfill (Louis Berger Group, Inc., 2004).

A modern landfill is an engineered facility with protective liners and caps to isolate the waste from the larger environment. The MSW is placed in an excavated cell, usually lined with high-density polyethylene to prevent leakage into the groundwater. A landfill must apply cover material of earth or some kind of nonputrescible material to the working face of the MSW daily. Drilling muds and wastewater streams that have been solidified may often serve as daily cover. Use of this type of material often improves a site's soil balance, meaning the volume of soil required over the life of the landfill for its construction and operation will be less than if these materials were not available and other soils had to be hauled in at a cost. Up to a point, the materials consume no airspace since they are merely displacing soils that would be used for cover in any event. For this reason, landfills will often accept these materials at a reduced price, or even at no charge. In addition to everyday municipal solid waste, certain approved landfills will take decommissioned oil and gas processing equipment and piping (Louis Berger Group, Inc., 2004).

Since 1947, when offshore production first began in the Gulf, the industry has removed more than 2,200 structures from Federal waters. The number and type of structures removed varies considerably from year to year but during the last decade about 125 structures per year were removed (Kaiser, 2005). Some obsolete platforms are donated to artificial reef programs. But, for those that are not, a typical decommissioning involves the oil and gas processing equipment and piping being taken ashore for refurbishment and reuse, selling as scrap, or disposal in an approved landfill. Although companies typically recycle piling and conductors, there are few opportunities for reusing topsides equipment because of age, corrosion, and changes in technical standards (Kaiser, 2005).

The destruction of Hurricane Katrina created an incredible amount of debris. As of February 2006, the Louisiana Dept. of Environmental Quality gave the following estimates for waste management: 16-17 million cubic yards of debris hauled away; 29,025 drums of hazard waste; 27,067 propane tanks; 1,782,424 small containers of hazardous waste; 221,456 refrigerators and 29,123 freezers; 27,920 air conditioners; 111,418 washer/dryers; 53,566 stoves; 34,567 water heaters; and 32,719 dishwashers

(Holden et al., 2006). Some of the platforms destroyed by Hurricanes Katrina and Rita (**Chapter 3.3.5.7.3**) will be sunk to create artificial reefs, and some of the materials will be recycled; however, a large part of these destroyed platforms and rigs will wind up in Gulf Coast landfills.

3.3.5.8.8. Coastal Pipelines

This section discusses OCS pipelines in coastal waters (State offshore and inland waters) and coastal onshore areas. The OCS pipelines near shore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland. See **Chapter 3.3.5.9.2** for a discussion of pipelines supporting State oil and gas production.

About 250 of the active OCS pipelines cross the Federal/State boundary into State waters. There are nearly 1,900 km (1,181 mi) of OCS pipelines in State waters. Over half of the pipelines in State waters are directly the result of the OCS Program.

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Gulfwide, about 60 percent of OCS pipelines entering State waters tie into existing pipeline systems and do not result in new pipeline landfalls. Because of the extensive trunklines that parallel the Texas coastline, this ratio is lower in Texas. About 80 percent of OCS pipeline landfalls are in Louisiana. The oldest pipeline systems are also in Louisiana; some date back to the 1950's. There are over 100 active OCS pipelines making landfall, resulting in 200 km (124 mi) of pipelines onshore, with an average of 2 km (1 mi) per pipeline. About 80 percent of the onshore length of OCS pipelines is in Louisiana with the longest resulting in 50 km (31 mi). About 20 percent of the onshore length of OCS pipelines is in Texas. A small percentage of onshore pipelines in the EIA's is directly the result of the OCS Program.

3.3.5.8.9. Coastal Barging

A general discussion of barging operations from offshore platforms to onshore terminals is found in **Chapter 3.3.5.7.2.2**. A discussion of the onshore barge terminals is found in **Chapter 3.3.5.8.6.2**.

There is a tremendous amount of barging that occurs in the coastal waters of the GOM, and no estimates exist of the volume that is attributable to the OCS industry. Secondary barging of OCS oil often occurs between terminals or from terminals to refineries. Oil that is piped to shore facilities and terminals is often subsequently transported by barge up rivers, through the Gulf Intracoastal Waterway, or along the coast.

3.3.5.9. State Oil and Gas Activities

3.3.5.9.1. Leasing and Production

Texas

The Texas coast is the largest along the GOM, spanning 367 mi with 3,300 mi of bay shoreline. Initially, all coastal states owned 3 nmi of land into the GOM; however, with the enactment of the Submerged Lands Act and its interpretation by the Supreme Court in 1960, Texas land extends 10.4 mi offshore. The State of Texas has authority over and owns the water, beds, and shores of the GOM, equaling approximately 2.5 million ac (Texas General Land Office, 2005a).

The Texas General Land Office is directly responsible for the management of more than 22 million ac of land that remains in the public domain. According to the Relinquishment Act of 1919, a surface owner acts as leasing agent for the State on privately owned land where the State retains the mineral rights, and the State and surface owner share rentals, royalties, and bonuses. The Texas Land Commissioner is authorized to lease designated public land for oil and gas production, and it now accounts for most of the income derived from public land. The State receives revenues from royalties, rentals, and bonuses. The Railroad Commission of Texas is the agency charged by the Texas Legislature with the regulation of the oil and gas industry in the State of Texas. The Commission's primary regulatory responsibilities are protecting the correlative rights of the mineral interest owners, preventing the waste of otherwise recoverable natural resources, and protecting the environment from pollution by oil and gas exploration and production activities. The Lands and Minerals Division of the Texas General Land Office holds lease sales quarterly in January, April, July, and October. Sales are usually held on the first Tuesday of the month; however, the January and July sales have been held in recent years on the second Tuesday of the month because of holidays. The last lease sale was held in Austin, Texas.

On July 27, 2006, the Railroad Commission reported the following oil and gas statistics for May and June 2006 (Railroad Commission of Texas, 2006b). In June 2006, 1,718 original drilling permits were issued, compared with 1,396 in June 2005 (23% increase). The June 2006 total included 1,440 permits to drill new oil and gas wells. Production in May 2006 came from 133,636 oil and 71,287 gas wells. In May 2006, crude oil production averaged 883,157 bbl daily, which is a 4 percent decrease from May 2005. Gas production was 428,033,594 Mcf of gas in May 2006, which is a <1 percent increase from May 2005. Total well completions year to date for 2006 are 6,275, up 21 percent from the same period in 2005. There was a 72 percent increase in the number of holes plugged (1,116) in June 2006 compared with June 2005. Of the four Strategic Petroleum Reserves (SPR's) in the U.S., Texas is home to two facilities: Bryan Mound and Big Hill. In 2004, Texas produced 19.8 percent of total U.S. oil production and 26 percent of the Nation's natural gas production. Also, in 2004, Texas ranked second for crude oil production with over 1,000 bbl per day, including Federal offshore areas. Among the 50 states, Texas ranks the highest in the Nation in refining capacity. The combined distillation capacity of the State's 26 refineries totals more than 4.6 million bbl per calendar day, equaling about 26 percent of the Nation's refining capacity. There were 151,653 producing oil wells and 506 rotary rigs operating in 2004 (USDOE, EIA, 2006i).

In 2004, more than 152,500 persons were employed in the oil and gas production industry, 77,443 persons in the chemical industry, 24,240 persons in the oil refining industry, and 12,174 persons in the pipeline transmission industry (USDOC, Bureau of Economic Analysis, 2006).

Louisiana

Since the 1930's Louisiana has lost over 1,900 mi^2 of land. Between 1990 and 2000 wetland loss was approximately 24 mi^2 per year. While Louisiana has only 30 percent of the total coastal marsh found in the lower 48 states, it accounts for 90 percent of the coastal marsh loss experienced by these states (LADNR, 2006a). The first oil production in commercial quantities occurred in 1901 and it marked the beginning of the industry in the State. The first over-water drilling in America occurred in 1910 in Caddo Lake near Shreveport. The State began its offshore history in 1947. The territorial waters of Louisiana extend Gulfward for 3 nmi and its shoreline extends nearly 350 mi.

The Office of Mineral Resources holds regularly scheduled lease sales on the second Wednesday of every month. The April 12, 2006, lease sale conducted by the State Mineral Board in Baton Rouge, Louisiana, generated the following summary results: 79 tracts nominated and the sale brought in $2.9 million and 28 leases. Of that total, two State offshore leases were awarded for $1.3 million (LADNR, 2006b).

Hurricanes Katrina and Rita (2005) also affected State oil and gas production. As of March 2006, 85.5 percent of the daily oil production capacity of a 38-parish region had been restored, and 97 percent of the daily gas production capacity had been restored (LADNR, 2006c). Both Texas and Louisiana are home to two SPR storage facilities. Louisiana's offshore fields of West Hackberry and Bayou Choctaw account for approximately 2 percent of the Nation's proved oil reserves and ranks 5th for crude oil production with more than 228,000 bbl per day if the associated Federal offshore areas are included. There are 17 petroleum refineries in Louisiana with a combined crude oil distillation capacity of almost 2.8 MMbbl per calendar day as of 2005. This is the second highest rate in the nation after Texas. The ExxonMobil Refining and Supply Company in Baton Rouge, Louisiana, is the 2nd largest refinery in the U.S. in terms of distillation capacity. There were 19,970 producing oil wells and 167 rotary rigs operating in 2004 (USDOE, EIA, 2006j).

In 2006, 18,798 persons were employed in the oil and gas production industry, nearly 24,000 persons in the chemical industry, 10,088 persons in the oil refining industry, and 2,049 persons in the pipeline transmission industry (USDOC, Bureau of Economic Analysis, 2006).

Mississippi

The Mississippi coast spans for more than 40 mi (64 km) along the GOM and encompasses 359 mi (578 km) of tidal shoreline. The State of Mississippi only has an onshore oil and gas leasing program. In

1994, the State of Mississippi passed legislation allowing companies to enjoy substantial tax breaks based on the types of discovery involved and the methods they use onshore. Those tax breaks range from a 5-year exemption from the State's 6-percent severance tax for new discoveries to a 50-percent reduction in the tax for using 3D technology to locate new oil and gas fields, or using enhanced recovery methods. As a result of the incentive program, 84 new oil pools have received the exemption, 108 inactive wells have been brought back into production, 13 development wells have been drilled in existing fields, 34 enhanced wells have received exemption, and 14 have received exemptions for using 3D technology (Sheffield, 2000).

In 2004, Mississippi accounted for approximately 1 percent of the nations crude oil proved reserves and crude oil production. Mississippi ranked 14^{th} for crude oil proved reserves with over 47,000 bbl per day and 13^{th} for crude oil production with 178 million bbl. Both rankings include Federal offshore areas. Mississippi's petroleum infrastructure includes four refineries and a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. As of 2005, the four refineries combined had a 364,800 bbl per calendar day capacity. Of the four refineries, the Chevron refinery in Pascagoula is the 8^{th} largest refinery in the Nation with 325,000 bbl per calendar day. A major propane supply hub is located at Hattiesburg, Mississippi, where the Dixie Pipeline has a network of terminals and storage facilities. There were 1,412 producing oil wells and ten rotary rigs operating in 2004 (USDOI, EIA, 2006k).

In 2004, 4,264 persons were employed in the oil and gas production industry, 7,217 persons in the chemical industry, 2,151 persons in the oil refining industry, and 827 persons in the pipeline transmission industry (USDOC, Bureau of Economic Analysis, 2006).

Alabama

The territorial waters of Alabama extend Gulfward for 3 nmi and its shoreline extends 52 mi. The first wells drilled for oil in the southeastern U.S. were drilled in Lawrence County in 1865, just 6 years after the first oil well was drilled in the U.S. The first commercially marketed natural gas production in the southeastern U.S. occurred in the early 1900's near Huntsville, Alabama. In 1979, gas was first discovered by Mobil Oil Exploration & Producing Southeast, Inc in the mouth of Mobile Bay.

The State of Alabama owns oil, gas, and mineral interests on small upland tracts, submerged river bottoms, estuaries, bays, and in the 3-nmi area offshore. Most significant economically are the natural gas reserves lying within the 3-nmi offshore area of Mobile and Baldwin Counties. The Alabama State Oil and Gas Board was created after the oil discovery in 1944 in Choctaw County and is responsible for regulating the exploration and development of these natural resources. The discovery of Alabama's giant Citronelle Field in Mobile County in 1955 focused national attention on the State's oil and gas potential. Major discoveries of natural gas in the 1980's led to the development of an array of natural gas reservoirs (State Oil and Gas Board of Alabama, 2006).

Alabama has no established schedule of lease sales. The limited number of tracts in State waters has resulted in the State not holding regularly scheduled lease sales. Alabama has reaped tremendous financial benefits from the development of offshore mineral resources. Revenues include severance taxes, bonuses, royalties, and rentals.

In 2004, Alabama accounted for less than 1 percent of the Nation's crude oil proved reserves and crude oil production. Alabama ranked 18^{th} for crude oil proved reserves with over 53 MMbbl and 15^{th} for crude oil production with 20,000 bbl per day in 2004. Both rankings include Federal offshore areas. Alabama has three refineries. In 2005, the three refineries combined operable distillation capacity was 113,500 bbl per calendar day. There were 824 producing oil wells and 3 rotary rigs operating in 2004 (USDOE, EIA, 2006l). In 2004, approximately 1,900 persons were employed in the oil and gas production industry, 10,265 persons in the chemical industry, 2,153 persons in the oil refining industry, and 538 persons in the oil pipeline transmission industry (USDOC, Bureau of Economic Analysis, 2006).

Florida

The shoreline of Florida extends more than 1,300 mi. The State of Florida has experienced very limited drilling in coastal waters. In June 2005, Florida's Governor Jeb Bush and the Florida Cabinet signed a historic settlement agreement to eliminate the potential for oil drilling in State waters for $12.5 million (Florida Dept. of Environmental Protection, 2005).

At present, no drilling rigs are operating within the State waters. Although Florida does not have any refineries, the State does have some indigenous crude oil production onshore, totaling 8,000 bbl per day in 2004. This ranks Florida 20th out of the oil-producing states, including Federal offshore areas. There were 70 producing oil wells and 1 rotary rig operating in 2004 (USDOI, EIA 2006m). In 2004, over 7,580 persons were employed in the oil and gas production industry, 22,380 persons in the chemical industry, and 255 persons in the oil pipeline transmission industry (USDOC, Bureau of Economic Analysis, 2006).

3.3.5.9.2. State Pipeline Infrastructure

The pipeline network in the Gulf Coast States is extensive. Pipelines transport crude oil and natural gas from the wellhead to the processing plants and refineries. Pipelines transport natural gas from producing states such as Texas and Louisiana and to a lesser extent Mississippi and Alabama to utility companies, chemical companies, and other users throughout the Nation. Pipelines are used to transport refined petroleum products such as gasoline and diesel from refineries in the GOM region to markets all over the country. Pipelines are also used to transport chemical products (Louisiana Mid-Continent Oil and Gas Association, 2006).

The natural gas pipeline network has grown substantially since the 1990's nationwide. The increasing growth in natural gas demand over the past several years has led to an increase in the utilization of pipelines and has resulted in some pressure for expansion in several areas. In the GOM, a number of offshore pipeline projects have been completed in recent years. In 2003, three major deepwater offshore gas pipeline systems were completed, primarily to serve new deepwater platforms. The largest of the three was the Okeanos Deepwater Pipeline (Phase 1), a 119-km (74-mi), 24-inch, 1.2 Bcf/d pipeline serving the NaKika field complex 240 km (150 mi) southeast of New Orleans (USDOE, EIA, Office of Oil and Gas, 2004a). In 2004, six offshore deepwater projects added 501 km (311 mi) of pipeline and 1.8 Bcf/d of capacity in the GOM (USDOE, EIA, Office of Oil and Gas, 2005c). Most of these projects transport gas to interconnections with existing systems, such as the Destin and Nautilus pipelines, that transport natural gas onshore.

Louisiana

The pipeline industry is a vital part of the oil and gas industry in Louisiana. Over 40,233 km (25,000 mi) of pipe move natural gas through interstate pipeline, and over 12,231 km (7,600 mi) of pipe carry natural gas through intrastate pipelines to users within the State's boundaries. Another 5,552 km (3,450 mi) of pipeline in Louisiana transport crude oil and crude oil products (Louisiana Mid-Continent Oil and Gas Association, 2006). There are thousands of kilometers of flowlines and gathering lines moving oil and gas from the wellhead to separating facilities, while other pipelines transport chemical products with no petroleum base. Louisiana is home to the world's only offshore superport, LOOP, which enables supertankers to unload crude oil away from shore so that it can be transported via pipeline to onshore terminals. The port facility is located in the GOM, 29 km (18 mi) south of Grand Isle, Louisiana. Four pipelines connect the onshore storage facility to refineries in Louisiana and along the Gulf Coast. LOOP also operates the 85-km (53-mi), 48-in LOCAP pipeline that connects LOOP to Capline at St. James Parish, Louisiana. Capline is a 40-in pipeline that transports crude oil to several Midwest refineries (Louisiana Offshore Oil Port, 2001).

The Henry Hub in Louisiana is a hub of pipelines and is the point where financial markets determine the value of natural gas. The Henry Hub interconnects nine interstate and four intrastate pipelines, including Acadian, Columbia Gulf, Dow, Equitable (Jefferson Island), Koch Gateway, LRC, Natural Gas Pipe Line, Sea Robin, Southern Natural, Texas Gas, Transco, Trunkline, and Sabine's mainline. Collectively, these pipelines provide access to markets in the Midwest, Northeast, Southeast, and Gulf Coast regions of the U.S. (USDOE, EIA, 2006).

Mississippi

The petroleum infrastructure in Mississippi includes a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. A major propane supply hub is the Dixie Pipeline; it has a network of terminals and storage facilities. Major pipelines for crude oil are operated by EOTT Energy, Genesis, Hunt, Shell, Mid-Valley, Scurlock-Permian, and BP. Major pipelines for liquefied petroleum gas are operated by Dixie, Plantation, and Enterprise BP (USDOE, EIA, 2005e).

Alabama

The petroleum infrastructure in Alabama includes a somewhat extensive network of crude oil, product, and liquefied petroleum gas pipelines. Major pipelines for crude oil are operated by Hess, Hunt, Genesis, Citronelle-Mobile, and Miller. Major pipelines for products are Amoco, Colonial, and Plantation. Major pipelines for liquefied petroleum gas are operated by Dixie and Enterprise (USDOE, EIA, 2005f).

Florida

The petroleum infrastructure in Florida includes a limited network of crude oil, product, and liquefied petroleum gas pipelines. Genesis and Sunniland operate major pipelines for crude oil. Enterprise operates major pipelines for liquefied petroleum gas (USDOE, EIA, 2005g).

Hurricane Impacts

Damage to onshore pipelines and pipelines in State waters from Hurricane Katrina was minimal. Colonial and Plantation petroleum product pipelines, which provide the majority of gasoline, diesel fuel, and jet fuel to the Southeast, Mid-Atlantic, and Northeast states, lost power at key pump stations in Louisiana and Mississippi. Dixie Pipeline (the propane line) was also shut down, as was Capline, the crude oil pipeline serving the Midwest (USDOE, Office of Electricity Delivery and Energy Reliability, 2005e). Most natural gas transmission pipelines in the path of Hurricane Katrina survived with minimal damage (USDOE, Office of Electricity Delivery and Energy Reliability, 2005f). For most, there were temporary power outages and reduced operating capacity because of constraints in the supply chain.

The damage from Hurricanes Katrina and Rita to offshore pipelines varied in pattern, but there was a degree of similarity (USDOE, Office of Fossil Energy, 2006). In general, approximately half of the pipeline breaches occurred within an area that also experienced damaged or destroyed platforms. All but a half dozen of the pipeline breaches occurred in the waters of the continental shelf (i.e., in water depths of 200 m (656 ft)or less) with half of the continental shelf breaches located within 5 mi (8 km) of the transition from deep water. As the continental shelf is closer to the shoreline in the eastern part of the hurricane impact area, approximately half of the breaches occurred within 5 mi (8 km) of the shoreline in the South Timbalier and Main Pass areas or in the waters surrounding the Plaquemines Peninsula and Lafourche Parish. Hurricane Katrina caused almost double the number of natural gas pipeline breaches caused by Hurricane Rita. Hurricane Katrina's breaches, being in the eastern portion of the damage area, generally occurred closer to the shore, while the pipeline breaches caused by Hurricane Rita were more randomly distributed along the path of the hurricane.

Chapter 3.3.5.7.3, Damage to Offshore Infrastructure from Recent Hurricanes, discusses damage to OCS pipelines.

3.3.5.10. Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, which directs Federal agencies to assess whether their actions have disproportionate environmental effects on people of ethnic or racial minorities or with low incomes. Those environmental effects encompass human health, social, and economic consequences. The Federal agency in charge of the proposed action must provide opportunities for community input during the NEPA process (see **Chapter 5** for a discussion of scoping, and community consultation and coordination).

Environmental justice concerns may be related to nearshore and onshore activities that result from a proposed action. These concerns are addressed in two categories—those related to routine operations and those related to nonroutine events (accidents). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to or expansions of the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). Concerns related to nonroutine events focus on oil spills.

The OCS Program in the GOM is large and has been ongoing for more than 50 years. During this period, substantial leasing has occurred off Texas, Louisiana, Mississippi, and Alabama. An extensive support infrastructure system exists consisting of platform fabrication yards, shipyards, repair and maintenance yards, onshore service bases, heliports, marinas for crewboats and supply boats, pipeline coating companies, waste management facilities, gas processing plants, petrochemical plants, and gas and petroleum pipelines. This infrastructure system is both widespread and concentrated. Much infrastructure is located in coastal Louisiana, less in coastal Texas, and less still in Mississippi's Jackson County and Alabama's Mobile County. While many fabrication and supply facilities are concentrated around coastal ports, downstream processing is concentrated more in industrial corridors farther inland. Support system infrastructure is described in **Chapter 3.3.5.8**. The potential impacts to and from infrastructure is an ongoing concern for Gulf Coast States and communities. The MMS is currently conducting several studies to obtain and refine pertinent information.

Conducting environmental justice assessments in the GOM has been problematic for the following reasons. First, the U.S. GOM is a geopolitical area containing a large number of potentially affected minority and low-income populations. Second, the nature of the OCS leasing program makes it hard to predict where the onshore effects of offshore lease sales will occur. Third, each industry sector is associated with particular impacts that are often cumulative based on the mix of activities occurring in each geographic location. A recent MMS study describes the major categories of existing OCS-related infrastructure: platform fabrication yards, port facilities, shipyards and shipbuilding yards, support and transport facilities, waste management facilities, pipelines, pipecoating yards, natural gas processing facilities, natural gas storage facilities, refineries, and petrochemical facilities (Louis Berger Group, Inc., 2004). **Figures 3-13 through 3-15** illustrate the distribution of the facilities identified throughout the Gulf Coast.

There are 81 counties that contain facilities, with 5 being the median number of facilities across these counties. The 39 counties that contain more than 5 facilities are defined as having a concentrated level of infrastructure. These are further divided into three levels of concentration: low (6-15 facilities); medium (16-49 facilities); and high (50 or more facilities). As shown in **Table 3-40**, all but one of the counties considered to have a high concentration of infrastructure are located in Louisiana (5 counties) or Texas (4 counties). Most of the counties considered to have low and medium concentration are also located in these two states.

Environmental justice maps (**Figures 3-21 through 3-26**) display the location of oil-related infrastructure and the distribution of low-income and minority residents across GOM counties and parishes. These maps illustrate possible disproportionate effects on low-income or minority groups in the region. Ten counties (or parishes in Louisiana) are considered to have a high concentration of oil-related infrastructure (**Table 3-40**). Of these 10 counties, 5 have higher minority percentages than their respective state average. These counties and parishes include Mobile, Alabama; St. Mary, Louisiana; Galveston, Harris and Jefferson, Texas. Only 2 of the 10 high infrastructure concentration counties and parishes also have higher poverty rates than their respective State poverty rate. Both St. Mary Parish in Louisiana and Jefferson County in Texas have higher poverty rates than the mean poverty rates in their states.

Fifteen counties and parishes are considered to have a medium concentration of oil-related infrastructure (**Table 3-40**). Five of these parishes or counties have a higher poverty rate than the mean rate in their state. These include Iberia, Orleans and Vermilion Parishes in Louisiana and Nueces and San Patricio Counties in Texas. Eight of the 15 medium concentration counties also have higher minority populations than their state averages. These counties and parishes include Hillsborough, Florida; East Baton Rouge, Iberia, Orleans and St. James, Louisiana; and Calhoun, Nueces and San Patricio, Texas. Because of the concentration of OCS-related facilities and high poverty and/or minority rates, these communities are critical when determining potential effects of industry activities on low-income or minority populations.

The MMS has recently investigated an area of potential environmental justice concern in Lafourche Parish, Louisiana (Hemmerling and Colten, 2003). Five different classes of relevant OCS activities exist in the region, including transportation corridors, oil and natural gas pipelines, petroleum bulk storage facilities, shipyards, and a natural gas processing plant. The majority of OCS-related infrastructure is located in south Lafourche Parish where the Houma Indian population is clustered. According to Hemmerling and Colten, south Lafourche Parish still provides valuable habitat land for traditional subsistence activities such as hunting, fishing, and trapping practiced by the Houma and other groups in the area (Hemmerling and Colten, 2003). Minority populations in this area could sustain disproportionate effects should an accident occur.

A similar MMS study entitled *Environmental Justice: A Comparative Perspective in Louisiana* (Hemmerling and Colten, in preparation) has been conducted in Jefferson and St. Bernard Parishes. As with the Lafourche Parish study, it is using GIS-based techniques to identify and assess impacts from different sectors of the oil extraction and processing industry.

Potentially vulnerable minority populations also reside along the Gulf Coast. **Figures 3-21 through 3-23** indicate the substantial proportions of African-American and Hispanic persons along the coast. The Hispanic population tends to be concentrated in Texas and south Florida. The African-American population makes up a significant proportion of the population along the central Gulf Coast. Another minority group of concern is Native Americans. Using 1999 estimates from the Bureau of the Census, it is possible to identify counties and parishes with significant populations of Native Americans. While most of the percentages are quite small—three-quarters are 0.5 percent or less—there are a handful of counties or parishes with more than a 2-percent Native American population. The Mowa Choctaw tribe of Washington County, Alabama, constitutes 5 percent of the county's population. The United Houma Nation represents 4 percent of the population of Terrebonne Parish, Louisiana, and just over 2 percent of Lafourche Parish, Louisiana. The Alabama-Coushatta tribe is 2 percent of the population of Polk County, Texas. Increased oil and gas activities in these areas could affect these Native American populations. Lafourche Parish, Louisiana, especially, is already serving as one of the few deepwater servicing facilities on the Gulf Coast.

On August 29, 2005, Hurricane Katrina made landfall on the Gulf Coast between New Orleans, Louisiana, to the west, and Mobile, Alabama, to the east. Hurricane Katrina had differential impacts on the Gulf Coast population. Approximately one-half of the displaced population lived in New Orleans, Louisiana, where the storm heavily impacted the poor and African Americans (Gabe et al., 2005). In addition, the three states where communities were damaged or flooded rank among the poorest in the country. For example, according to the 2000 U.S. Census, Mississippi ranked second only to the District of Columbia in its poverty rate. Louisiana ranked third and Alabama ranked sixth in the country. Approximately one-fifth (21%) of the population most directly affected by the storm was poor. This poverty rate is significantly higher than the national poverty rate of 12.4 percent reported in the 2000 Census. Furthermore, it is estimated that over 30 percent of the most impacted population had incomes below one-and-one-half times the poverty line and over 40 percent had incomes below twice the official poverty line (Gabe et al., 2005).

Hurricane Katrina also disproportionately affected African-Americans living in New Orleans, Louisiana. An estimated 310,000 (44% of total storm victims) African-Americans were directly impacted by the storm, primarily as a result of flooding in Orleans Parish, Louisiana. In Orleans Parish, approximately 272,000 (73% of the affected population) blacks were displaced. It is estimated that 101,000 non-black residents in Orleans Parish were displaced to flooding or damage. Although 63 percent of the non-black population in Orleans Parish was also displaced from their homes, the percentage is lower than that experienced by blacks. Among blacks in Orleans Parish, Louisiana, over one-third (89,000 or 34% of displaced blacks) were estimated to have been poor in the 2000 Census. Approximately 14.6 percent (14,000) of the non-black (predominately white) displaced residents were poor (Gabe et al., 2005). (Also see **Chapter 3.3.5.4.1**, Population, for further discussion of the effect of Hurricanes Katrina and Rita on minority populations).

Hurricane Katrina lifted and dislodged a partially filled 250,000-bbl aboveground storage tank at the Murphy Oil Refinery, which is a part of the Meraux oil facility located in Meraux, St. Bernard Parish, Louisiana. During the time of impact, the tank contained 85,000 bbl of mixed crude oil, and approximately 25,110 bbl (1.05 million gallons) were released. The released oil affected approximately 1,800 homes in an adjacent residential neighborhood in an area of approximately 1 mi^2. The primary contaminants detected in soil sediments were polynuclear aromatic hydrocarbons (PAH's), diesel and oil range organic chemicals, and arsenic. The USEPA is monitoring Murphy Oil's sampling and cleanup at residential properties, parks, roads, sidewalks, and other public spaces that were contaminated by the spill. The USEPA is also identifying and characterizing the full extent of contamination in the area by providing written and photographic documentation of response activities and monitoring removal activities (USEPA, 2006b). Communities such as St. Bernard Parish, Louisiana, are potentially vulnerable to such accidents because of their close proximity to OCS-related infrastructure.

CHAPTER 4

ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

4. ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

4.1. IMPACT-PRODUCING FACTORS AND SCENARIO — ROUTINE OPERATIONS

4.1.1. Offshore Impact-Producing Factors and Scenario

This section describes the offshore infrastructure and activities (impact-producing factors (IPF's) associated with the proposed actions and with the OCS Program in the Western Planning Area (WPA) and Central Planning Area (CPA) that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico (GOM). No OCS offshore activities are projected to occur within the Eastern Planning Area (EPA). Offshore is defined here as the OCS portion of the GOM that begins 10 mi offshore Florida; 3 nmi offshore Louisiana, Mississippi, and Alabama; and 3 leagues offshore Texas; and it extends seaward to the limits of the Exclusive Economic Zone (EEZ) (**Figure 1-1**). Coastal infrastructure and activities associated with the proposed actions and the OCS Program are described in **Chapter 4.1.2**, Coastal Impact-Producing Factors and Scenario.

Offshore activities are described in the context of scenarios for the proposed actions and for the OCS Program. The MMS's GOM OCS Region developed these scenarios to provide a framework for detailed analyses of potential impacts of the proposed lease sales. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production activities and facilities, both offshore and onshore. Each proposed action is represented by a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors. Each of the proposed sales is expected to be within the scenario ranges; therefore, a proposed action is representative of the individual proposed sales in each sale area. The scenarios do not predict future oil and gas activities with absolute certainty, even though they were formulated using historical information and current trends in the oil and gas industry. Indeed, these scenarios are only approximate since future factors such as the contemporary economic marketplace, the availability of support facilities, and pipeline capacities are all unknowns. Notwithstanding these unpredictable factors, the scenarios used in this environmental impact statement (EIS) represent the best assumptions and estimates of a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses. The development scenarios do not represent an MMS recommendation, preference, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities.

The MMS assumes fields discovered as a result of a proposed action will reach the end of their economic life within 40 years of the lease sale. Activity levels are not projected beyond 40 years. This is based on averages for time required for exploration, development, production life, and abandonment for leases in the GOM. For the cumulative analysis, the OCS Program is discussed in terms of current activities, current trends, and projections of these trends into the reasonably foreseeable future. For modeling purposes and quantified OCS Program activities, a 40-year analysis period (year of the first lease sale (2007) through 35 years after the last lease sale (2012) as proposed in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (5-Year Program) is used. Activity projections become increasingly uncertain as the length of time for projections are made increases and the number of influencing factors increases. The projections used to develop the proposed actions and OCS Program scenarios are based on resource estimates as summarized in the *Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf 2006* (USDOI, MMS, 2006k), current industry information, and historical trends.

The statistics used for these historic trends exhibit a lag time of about two years; therefore, the models using the trends also reflect two-year-old statistics. In addition, the overall trends average out the "boom and bust" nature of GOM OCS operations. The models cannot fully adjust for short-term changes in the rates of activities. In fact, these short-term changes should not be projected into the long term. An example of a short-term change was the surge in deepwater activities in the mid-1990's as a result of technological advancements in seismic surveying and development options, as well as a reflection of deepwater royalty relief. This short-term effect was greater than the activity level predicted by the resources and socioeconomic models. The MMS believes that the models, with continuing adjustments and refinements, adequately project GOM OCS activities in the long term for the EIS analyses.

The proposed action and the Gulfwide OCS Program scenarios are based on the following factors:

- recent trends in the amount and location of leasing, exploration, and development activity;
- estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- industry information; and
- oil and gas technologies, and the economic considerations and environmental constraints of these technologies.

The proposed actions are WPA Sales 204, 207, 210, 215, and 218, and CPA Sales 205, 206, 208, 213, 216, and 222, as scheduled in the *Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012*. In general, each of the WPA proposed lease sales represents 3-5 percent of the OCS Program in the WPA based on barrels of oil equivalent (BOE) resource estimates, and 1 percent of the total OCS Program. The proposed CPA lease sales each represent 4-5 percent of the OCS Program in the CPA (3-4 percent of the total OCS Program). Activities associated with the proposed actions are assumed to represent those same percentages of OCS Program activities unless otherwise indicated.

Specific projections for activities associated with a proposed action are discussed in the following scenario sections. The potential impacts of the activities associated with a proposed action are considered in the environmental analysis sections (**Chapters 4.2 and 4.4**).

The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the analysis period. This includes projected activity from lease sales that have been held, including the most recent Lease Sale 200 (August 2006), but for which exploration or development has either not yet begun or is continuing. Activities that take place beyond the analysis timeframe as a result of future lease sales are not included in this analysis. The impacts of activities associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the cumulative environmental analysis section (**Chapter 4.5**).

In November 2002, MMS published the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007; Central Planning Area Sales 185, 190, 194, 198, and 201; Western Planning Area Sales 187, 192, 196, and 200; Final Environmental Impact Statement; Volumes I and II* (USDOI, MMS, 2002a). That EIS analyzed WPA Lease Sales 187, 192, 196, and 200. As in this EIS, a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors were developed for a "typical" WPA lease sale. The estimated amount of resources projected to be developed as a result of any one of the WPA lease sales was 0.136-0.262 BBO and 0.810-1.440 tcf of gas. As a result of any one of the WPA lease sales, it was projected that 37-115 exploration and delineation wells and 97-166 development wells would be drilled, 11-15 production structures would be installed, and 320-640 km of new pipeline would be installed, resulting in 0-1 new pipeline landfalls.

The MMS's fair market value evaluation is not yet complete for Lease Sale 200, and it will end on November 14, 2006. As of October 19, 2006, 293 leases have been accepted. Eighty-eight leases remain to be evaluated. Once MMS's evaluation is complete and the official number of accepted and rejected leases is known, the scenario for Lease Sale 200 can be reevaluated. Any change to the Lease Sale 200 scenario will appear in the Final EIS. For Lease Sale 196, 342 tracts were leased, 346 tracts were leased for Lease Sale 192, and 330 tracts were leased for Lease Sale 187.

4.1.1.1. Resource Estimates and Timetables

4.1.1.1.1. Proposed Actions

The proposed actions scenarios are used to assess the potential impacts of a proposed lease sale. The resource estimates for a proposed action are based on two factors: (1) the conditional estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the proposed lease sale areas;

and (2) estimates of the portion or percentage of these resources assumed to be leased, discovered, developed, and produced as a result of a proposed action. The estimates of undiscovered, unleased, conventionally recoverable oil and gas resources are based upon a comprehensive appraisal of the conventionally recoverable petroleum resources of the Nation as of January 1, 2003. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results were reported as a range of values corresponding to different probabilities of occurrence. A summarized discussion of the methodologies employed and the results obtained in the assessment are presented in the MMS brochure entitled, *Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf 2006* (USDOI, MMS, 2006k). The estimates of the portion of the resources assumed to be leased, discovered, developed, and produced as a result of a proposed action are based upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. A profusion of historical databases and information derived from oil and gas exploration and development activities are available to MMS and were used extensively. The undiscovered, unleased, conventionally recoverable resource estimates for a proposed action are expressed as ranges, from low to high. This range provides a reasonable expectation of oil and gas production anticipated from typical lease sales held as a result of the proposed action based on an actual range of historic observations.

Table 4-1 presents the projected oil and gas production for the proposed action and for the OCS Program. **Tables 4-2 and 4-3** provide a summary of the major scenario elements of the proposed actions and some of the related IPF's. To analyze IPF's for the proposed actions and the OCS Program, the proposed lease sale areas were divided into offshore subareas based upon ranges in water depth. **Figure 4-1** depicts the location of the offshore subareas. The water-depth ranges reflect the technological requirements and related physical and economic impacts as a consequence of the oil and gas potential, exploration and development activities, and lease terms unique to each water-depth range. Estimates of resources and facilities are distributed into each of the subareas.

Proposed Action Scenario: The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed WPA lease sale are 0.242-0.423 billion barrels of oil (BBO) and 1.644-2.647 trillion cubic feet (Tcf) of gas. The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed CPA lease sale are 0.776-1.292 BBO and 3.236-5.229 Tcf of gas.

The number of exploration and delineation wells, production platforms, and development wells projected to develop and produce the estimated resources for a WPA proposed action, and a CPA proposed action are given in **Tables 4-2 and 4-3**, respectively. The tables show the distribution of these factors by offshore subareas in the proposed lease sale areas. **Tables 4-2 and 4-34** also include estimates of the major IPF's related to the projected levels of exploration, development, and production activity.

For purposes of analysis, the life of the leases resulting from a proposed action is assumed to not exceed 40 years. Exploratory drilling activity takes place over an 8-year period, beginning within one year after the lease sale. Development activity takes place over a 39-year period, beginning with the installation of the first production platform and ending with the drilling of the last development wells. Production of oil and gas begins by the third year after the lease sale and continues through the 40^{th} year. Final abandonment and removal activities occur in the 40^{th} year.

4.1.1.1.2. OCS Program

OCS Program: Projected reserve/resource production for the OCS Program (28.562-32.570 BBO and 142.366-162.722 Tcf of gas) represents anticipated production from lands currently under lease (including the most recently held lease sale, Lease Sale 200) plus anticipated production from future lease sales over the 40-year analysis period. **Table 4-4** presents projections of the major activities and impact-producing factors related to future Gulfwide OCS Program activities.

Western Planning Area: Projected reserve/resource production for the OCS Program in the WPA (6.629-8.060 BBO and 52.211-59.961 Tcf of gas) represents anticipated production from lands currently under lease in the WPA (including the most recently held WPA lease sale, Lease Sale 200) plus anticipated production from future WPA lease sales over the 40-year analysis period. Projected production represents approximately 23-25 percent of the oil and 37 percent of the gas of the total

Gulfwide OCS Program. **Table 4-5** presents projections of the major activities and impact-producing factors related to future operations in the WPA.

Central Planning Area: Projected reserve/resource production for the OCS Program in the CPA (21.933-24.510 BBO and 90.155-102.761 Tcf of gas) represents anticipated production from lands currently under lease in the CPA, plus anticipated production from future CPA lease sales over the 40-year analysis period. Projected production represents approximately 75-77 percent of the oil and 63 percent of the gas of the total Gulfwide OCS Program. **Table 4-6** presents projections of the major activities and impact-producing factors related to future operations in the CPA.

Eastern Planning Area: No OCS activity is projected for the OCS Program in the EPA.

4.1.1.2. Exploration and Delineation

4.1.1.2.1. Seismic Surveying Operations

Geophysical seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. The MMS recently completed a programmatic EA (PEA) on geological and geophysical (G&G) activities on the GOM OCS (USDOI, MMS, 2004). The PEA includes a detailed description of seismic surveying technologies and operations. The G&G PEA is incorporated here by reference and summarized below. High-resolution surveys done in support of lease operations are authorized under the terms and conditions of the lease agreement, and are referred to as postlease surveys. Prelease surveys take into account similar seismic work performed off-lease and collectively authorized under MMS's G&G permitting process.

High-resolution seismic surveys collect data on surficial geology used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as chemosynthetic community habitat. Deep-penetration, CDP seismic surveys obtain data about geologic formations greater than 10,000 m (32,800 ft) below the seafloor. High-energy, marine seismic surveys include both 2D and 3D surveys. Data from 2D/3D surveys are used to map structural features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to identify and map habitats for chemosynthetic communities.

Prior to 1989, explosives (dynamite) were used in certain limited areas to generate seismic pulses needed for the surveys. However, the damaging environmental impacts associated with explosives' acoustical energy (high velocity and high peak pressure) led the seismic industry to replace the explosives with seismic airguns. Considered nonexplosive, the piston-type airguns use compressed air to create impulses with superior acoustic signals without generating the environmental impacts of explosives. Due to the decreased impacts, ease of deployment, and reduced regulatory timeframes that come with using airguns, it is assumed that no explosives would be used in future seismic surveys.

Typical seismic surveying operations tow an array of airguns and a streamer (signal receiver cable) behind the vessel 5-10 m (16-33 ft) below the sea surface. The airgun array produces a burst of underwater sound by releasing compressed air into the water column that creates an acoustical energy pulse. Depending on survey type and depth to the target formations, the release of compressed air every couple of seconds creates a regular series of strong acoustic impulses separated by silent periods lasting 7-16 seconds. Airgun arrays are designed to focus the sound energy downward. Acoustic (sound) signals are reflected off the subsurface sedimentary layers and recorded near the water surface by hydrophones spaced within streamer cables. These streamer cables are often 3 mi (5 km) or greater in length. Vessel speed is typically 4.5-6 knots (about 4-8 mph) with gear deployed.

The 3D seismic surveying enables a more accurate assessment of potential hydrocarbon reservoirs to optimally locate exploration or development wells and minimize the number of wells required to develop a field. State-of-the-art computers have the power to manipulate and process large tracks of 3D seismic data. The 3D surveys carried out by seismic vendors can consist of several hundred OCS blocks. Multiple-source and multiple-streamer technologies are used for 3D seismic surveys. A typical 3D survey might employ a dual array of 18 guns per array. Each array might emit a 3,000-in^3 burst of compressed air at 2,000 pounds per square inch (psi), generating approximately 4,500 kilojoule (kJ) of acoustic energy for each burst. At 10 m (33 ft) from the source, the pressure experienced is approximately ambient pressure plus 1 atmosphere (atm). The streamer array might consist of 6-8 parallel cables, each 6,000-8,000 m (19,685-26,247 ft) long, spaced 75 m (246 ft) apart. A series of 3D surveys collected over time, commonly referred to as a four-dimensional, 4D, or time-lapse survey, is used for reservoir management (to monitor how a reservoir is draining to optimize the amount of hydrocarbon that is produced).

Multicomponent data, sometimes referred to as 4C data, is a product of an emerging technology that incorporates recording the traditional seismic compressional (P) waves with a full complement of other wave types, but predominantly shear (S) waves. The 4C technology provides a second independent image of a geologic section as well as improves the lithology picture in structurally complex areas. It can also aid in reservoir fluid prediction. The 4C data may be 2D or 3D in nature and procedurally involves draped or towed ocean-bottom receiver cable(s) for acquisition. The 4C data can be used as a defining prelease tool or a postlease aid for reservoir prediction.

Postlease seismic surveying may include high-resolution, 2D, 3D, or 4D surveying. In addition, multicomponent data (2D-4C and 3D-4C data) may be collected to improve lithology and reservoir prediction. High-resolution surveying is done on a site-specific or lease-specific basis or along a proposed pipeline route. These surveys are used to identify potential shallow, geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as hard-bottom areas, topographic features, potential chemosynthetic community habitat, or historical archaeological resources. New technology has allowed for 3D acquisition and for deeper focusing of high-resolution data. It is assumed at least one postlease, high-resolution seismic survey would be conducted for each lease.

Deeper penetration seismic surveying (2D, 3D, or 4D) may also be done postlease for more accurate identification of potential reservoirs, increasing success rates for exploratory drilling and aiding in the identification of additional reservoirs in "known" fields. The 3D technology can be used in developed areas to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. It can also be used in developed areas for reservoir monitoring and field management. The 4D seismic surveying is used for reservoir monitoring and management, as well as in identifying bypassed "pay zones." Through time-lapsed surveys, the movement of oil, gas, and water in reservoirs can be observed over time. Postlease, deep seismic surveys may occur periodically throughout the productive life of a lease.

Under the Marine Mammal Protection Act (MMPA), MMS is seeking regulations governing the possible harassment and nonserious injury of several species of marine mammals in the GOM as a result of seismic surveys. As part of that request, MMS prepared projections of seismic surveys for a 5-year period (2004-2009). Projected operations were divided into three categories: deep seismic, high-resolution seismic, and vertical seismic profiling (VSP). Deep seismic operations would be conducted prelease, and high-resolution seismic and VSP operations would be conducted postlease. The MMS projected annually 95-130 VSP operations, 12,500-16,500 mi surveyed by high-resolution seismic, and 1,500-3,000 blocks surveyed by deep seismic.

Proposed Action Scenario: Because of the cyclic nature of seismic surveys, a prelease seismic survey would be attributable to lease sales held up to 7-9 years after the survey. It is projected that a proposed action in the WPA have or would result in 400-800 blocks surveyed by deep seismic operations and 1,000-2,000 blocks as a result of a proposed action in the CPA.

For postlease seismic surveys, it is projected a proposed action in the WPA would result in about 20 VSP operations and about 2,000 mi surveyed by high-resolution seismic during the life of the proposed action. It is projected a proposed action in the CPA would result in about 30 VSP operations and 3,000-4,000 mi surveyed by high-resolution seismic during the life of the proposed action.

OCS Program Scenario: Seismic surveys are projected to follow the same trend as exploration activities, which are projected to peak in 2008-2010, steadily decline until 2027, and remain relatively steady throughout the second half of the 40-year analysis period. During the first 2-4 years of the analysis period, it is projected annually there would be 95-130 VSP operations, 12,500-16,500 mi surveyed by high-resolution seismic, and 1,500-3,000 blocks surveyed by deep seismic. During the second half of the analysis period, it is projected annually there would be 60-70 VSP operations, 6,200-8,300 mi surveyed by high-resolution seismic, and 1,200-2,500 blocks surveyed by deep seismic.

4.1.1.2.2. Exploration and Delineation Plans and Drilling

Oil and gas operators use drilling terms that represent stages in the discovery and exploitation of hydrocarbon resources. An exploration well generally refers to the first well drilled on a prospective geologic structure to determine if a resource exists. If a resource is discovered in quantities appearing to be economic, one or more follow-up delineation wells help define the amount of resource or the extent of the reservoir.

In the GOM, exploration and delineation wells are typically drilled with mobile offshore drilling units (MODU's); for example, jack-up rigs, semisubmersible rigs, or drillships. The type of rig chosen to drill a prospect depends primarily on water depth. Because the water-depth ranges for each type of drilling rig overlap to a degree, other factors such as availability and daily rates play a large role when an operator decides upon the type of rig to contract. The table below indicates the depth ranges for exploration rigs used in this analysis for GOM MODU's.

MODU or Drilling Rig Type	Water-Depth Range
Jack-up	≤100 m
Semisubmersible	100-3,000 m
Drillship	≥600 m

The scenarios for the proposed actions assume that an average exploration/delineation well will require 30-45 days to drill. The actual time required for each well depends on a variety of factors, including the depth of the prospect's potential target zone, the complexity of the well design, and the directional offset of the wellbore needed to reach a particular zone. This scenario assumes that the average exploration or delineation well depth will be approximately 3,674 m (12,055 ft) below mudline.

Some delineation wells may be drilled using a sidetrack technique. In sidetracking a well, a portion of the existing wellbore is plugged back to a specific depth, directional drilling equipment is installed, and a new wellbore is drilled to a different geologic location. The lessee may use this technology to better understand their prospect and to plan future wells. Use of this technology may also reduce the time and exploration expenditures needed to help evaluate the prospective horizons on a new prospect.

The cost of an ultra-deepwater well (>6,000 ft water depth) can be \$30-\$50 million or more, without certainty that objectives can be reached. Some recent ultra-deepwater exploration wells in the GOM have been reported to have cost upwards of \$100 million.

Figure 4-2 represents a generic well schematic for a relatively shallow exploration well in the deepwater GOM. This well design was abstracted from actual well-casing programs from projects in the Mississippi Canyon and DeSoto Canyon OCS areas and from internal MMS data. A generic well configuration cannot capture all of the possible influences that impact how a well is designed. These influences include (1) unique geologic conditions at a specific well location, (2) directional drilling requirements, (3) potential sidetrack(s), or (4) company preferences. For exploratory wells, contingencies (such as anticipated water-flow zones in the formation) must also be considered in the casing program.

The threshold separating shallow- and deepwater drilling can range from 200 to 457 m (656 to 1,500 ft). For exploration and development, deepwater is defined as water ≥305 m (≥1,000 ft) deep and ultra-deepwater as ≥1,524 m (≥5,000 ft) deep. The drilling (spudding) of a deepwater exploration well begins with setting the conductor casing, one of the many sections or strings of casing (steel tube) installed in the wellbore. Each casing section is narrower (of a smaller diameter) than the preceding one, and each change in casing diameter is separated by a "shoe" (**Figure 4-2**). The drillstring (pipe, collar, and bit) drills the wellbore, and the casing is installed at certain depths within the well based on specific engineering and geologic criteria. The first casing set in the sea bottom (or mudline) can be large, approximately 30-40 in (75-100 cm) in diameter. The larger diameter pipe may be necessary when drilling through salt to reach subsalt objectives because more casing strings may be needed to reach the well's objective. The first string is emplaced by drilling or "jetting" out the unconsolidated sediment with a water jet as the largest casing pipe is set in place. The casing is cemented to the sea bottom and tested. Because the shallow sediments are frequently soft and unconsolidated, the next casing interval (1,000 ft or more below mudline) is commonly drilled with treated seawater and without a riser (a steel-jacketed tube that connects the wellhead to the drill rig and within which the drilling mud and cuttings circulate).

Drilling mud is generally not used when a riser is included in the system. The formation cuttings are discharged from the wellbore directly to the sea bottom. After the conductor casing is set a blowout preventer (BOP) is installed, commonly at the sea bottom, the riser is connected, and circulation for drilling muds and cuttings between the well bit and the surface rig is established.

Next, a repetitive procedure takes place until the well reaches its planned total depth: (1) drill to the next casing point; (2) install the casing; (3) cement the casing; (4) test the integrity of the seal; and (5) drill through the cement shoe and downhole until the next casing point is reached and a narrower casing string is then set. The casing points are determined by downhole formation pressure that is predicted before drilling with seismic wave velocities and by geological information from surrounding wells. As the well deepens, extra lengths of pipe (each about 100 ft long) are screwed onto the drill string at the rig floor to extend the length to the cutting bit. As a drill bit wears out from use, it must be replaced. The drilling downtime needed to retrieve the bit and replace it requires the drill string to be disassembled and reassembled. This process is referred to as "tripping" into or out of the hole. "Tripping" will also occur when a casing point is reached. The drill string is removed, the casing is "run" and cemented in the wellbore, the drill string is re-run into the wellbore, and drilling continues. The bottommost portion of a well is commonly left "open" (uncased) when the well reaches its total depth.

The MMS requires that operators conduct their offshore operations in a safe manner. Subpart D of the MMS's operating regulations (30 CFR 250) provides guidance to operators on drilling activities. For example, operators are required by 30 CFR 250.400 to take necessary precautions to keep their wells under control at all times using the best available and safest drilling technology (NTL 99-G01; "Deepwater Emergency Well Control Operations"). Deepwater areas pose some unique concerns regarding well-control activities. In 1998, the International Association of Drilling Contractors (IADC) published deepwater well-control guidelines (IADC, 1998) to assist operators in this requirement. These guidelines address well planning, well-control procedures, equipment, emergency response, and specialized training for drilling personnel.

As drilling activities occur in progressively deeper waters, operators may consider using MODU's that have onboard hydrocarbon storage capabilities. This option may be exercised if a well requires extended flow testing, 1-2 weeks or longer, in order to fully evaluate potential producible zones and to justify the higher costs of deepwater development activities. The liquid hydrocarbons resulting from an extended well test could be stored onboard a rig and later transported to shore for processing. Operators may also consider barge shuttling hydrocarbons from test well(s) to shore. There are some dangers inherit with barging operations if adverse weather conditions develop during testing. If operators do not choose to store produced liquid hydrocarbons during the well testing, they must request and receive approval from the MMS to burn test hydrocarbons. The MMS will only grant permission to flare or vent associated natural gas during well cleanup and for well-testing procedures for a limited period of time

Exploration Plans

The regulation at 30 CFR 250 Subpart B specifies the requirements for the exploration plans (EP's) that operators must submit to MMS for approval prior to deploying an exploration program. An EP must be submitted to MMS for review and decision before any exploration activities, except for preliminary activities, can begin on a lease. The EP describes exploration activities, drilling rig or vessel, proposed drilling and well-testing operations, environmental monitoring plans, and other relevant information, and includes a proposed schedule of the exploration activities. Guidelines and environmental information requirements for lessees and operators submitting an EP are addressed in 30 CFR 250.211 and further explained in NTL's 2006-G14 and 2006-G15. The NTL 2006-G14 provides guidance on information requirements and establishes the contents for OCS plans required by 30 CFR 250 Subpart B. This NTL, along with NTL 2006-G15, supersedes NTL 2003-G17. In the revised final **S**ubpart B regulations, the contents of an EP are given. The NTL 2006-G15 provides guidance for submitting OCS plans to the MMS GOMR.

The requirements for archaeological and shallow hazards surveys and their reports are specified in their own NTL's — 2005-G07 ("Archaeological Resource Surveys and Reports") and 98-20 ("Shallow Hazards Requirements").

Drilling Rig Availability

Competition for and availability of deepwater drilling rigs in the GOM may limit the availability of MODU's suitable for deepwater and ultra-deepwater prospects. Drilling activities may also be constrained by the availability of rig crews, shore base facilities, risers, and other equipment. A search on the Rigzone website (Rigzone, 2006) showed that operators in the GOM currently had commitments for the following rig classes: 118 jack-ups, 35 semisubmersibles, and 6 drillships. Operators had a rig utilization rate of about 85 percent, which means that at any time approximately 85 percent of these rigs are actively drilling. The Rigzone website indicates the total worldwide deployment capability for these MODU classes as 315 jack-ups, 140 semisubmersibles, and 33 drillships.

WPA Proposed Action Scenario: It is estimated that 42-66 exploration and delineation wells will be drilled as a result of a WPA proposed action. **Table 4-2** shows the estimated range of exploration and delineation wells by water depth subarea. Approximately 65-67 percent of the projected wells are expected to be on the continental shelf (0-200 m (0-656 ft) water depth) and 33-35 percent are expected in the intermediate water-depth ranges and deeper (>200 m (656 ft)).

CPA Proposed Action Scenario: It is estimated that 65-96 exploration and delineation wells will be drilled as a result of a CPA proposed action. **Table 4-34** shows the estimated range of exploration and delineation wells by water depth subarea. Approximately 33-40 percent of the projected wells for a CPA proposed action are expected to be on the continental shelf (0-200 m (0-656 ft) water depth) and about 60-68 percent are expected in intermediate water-depth ranges and deeper (>200 m (656 ft)).

OCS Program Scenario: It is estimated that 2,325-2,864 exploration and delineation wells will be drilled in the WPA and 5,010-6,569 in the CPA as a result of the OCS Program. **Tables 4-4, 4-5, and 4-6** show the estimated range of exploration and delineation wells by water depth subarea. Of these wells 69-71 percent are expected to be on the continental shelf (0-200 m (0-656 ft) water depth) and 29-31 percent are expected in intermediate water-depth ranges and deeper (>200 m (656 ft)).

4.1.1.3. Development and Production

4.1.1.3.1. Development and Production Drilling

Delineation and production wells are sometimes collectively termed development wells. A development well is designed to extract resource from a known hydrocarbon reservoir. After a discovery the operator must decide whether or not to complete the well without delay, to delay completion with the rig on station so that additional tests may be conducted, or to temporarily abandon the well site and move the rig off station to a new location and drill another well. Sometimes an operator will decide to drill a series of development wells, move off location, and then return with a rig to complete all the wells at one time. If an exploration well is clearly a dry hole, the operator permanently abandons the well without delay.

When the decision is made to complete the well, a new stage of activity begins. Completing a well involves preparing the well for production. The MMS estimates that 87 percent of development wells would become producing wells. The typical process includes setting and cementing the production casing, installing some downhole production equipment, perforating the casing and surrounding cement, treating the formation, setting a gravel pack (if needed), and installing production tubing. One form of formation treatment is known as "fracing." Fracing involves pressurizing the well to force chemicals or mechanical agents into the formation. Mechanical agents, such as sand or small microspheres (tiny glass beads), can be used to prop open the created factures that act as conduits to deliver hydrocarbons to the wellbore. Well treatment chemicals are commonly used to improve well productivity. For example, acidizing a reservoir to dissolve cementing agents and improve fluid flow is the most common well treatment in the GOM. After a production test determines the desired production rate to avoid damaging the reservoir, the well is ready to go online and produce.

Development wells may be drilled from movable structures, such as jack-up rigs, fixed bottom-supported structures, floating vertically-moored structures, floating production facilities, and drillships (either anchored or dynamically positioned drilling vessels). The spectrum of these production systems are shown in **Figure 3-19**.

The type of production structure installed at a site depends mainly on water depth, but the total facility lifecycle, the type and quantity of hydrocarbon production expected, the number of wells to be drilled, and the number of anticipated tie backs from other fields can also influence an operator's procurement decision. The number of wells per structure varies according to the type of production structure used, the prospect size, and the drilling/production strategy deployed for the drilling program and for resource conservation. Production systems can be fixed, floating, or increasingly in deep water, subsea. Advances in the composition of drilling fluids and drilling technology are likely to provide operators with the means to reduce rig costs in the deepwater OCS program.

Until recently, there had been a gradual increase of drilling depth (as measured in true vertical depth (TVD)). Beginning in 1996, the maximum drilling depth increased rapidly, reaching depths below 9,144 m (30,000 ft) in 2002. The Transocean *Discoverer Spirit* (Green Canyon Block 512) drilled the deepest well in the GOM to date, reaching a TVD of 10,411 m (34,157 ft) in December 2005. The recent dramatic increase in TVD may be attributed to several factors, including enhanced rig capabilities, deeper exploration targets, royalty relief for shallow water, deep gas prospects, and the general trend toward greater water depths.

The MMS has described and characterized production structures in its deepwater reference document (Regg et al., 2000). These descriptions are summarized in **Chapter 3.3.5.7.1** and were used in preparing the scenario for this EIS. In water depths of up to 400 m (1,312 ft), the scenarios assume that conventional, fixed platforms that are rigidly attached to the seafloor will be the type of structure preferred by operators. In water depths of <200 m (656 ft), 20 percent of the platforms are expected to be manned (defined as having sleeping quarters on the structure). In depths between 200 and 400 m (656 and 1,312 ft), all structures are assumed to be manned. It is also assumed that helipads will be located on 66 percent of the structures in water depths <60 m (197 ft), on 94 percent of structures in water depths between 60 and 200 m (656 ft), and on 100 percent of the structures in water depths >200 m (656 ft). At water depths >400 m (1,312 ft), platform designs based on rigid attachment to the seafloor are not expected to be used. The 400-m (1,312-ft) isobath appears to be the current economic limit for this type of structure.

Industry Challenges and Emerging Technologies

In recent years, operators have pushed into ever deeper water in parallel with increasingly deeper wells (in TVD). Deeper wells have pushed current drilling procedures and materials into a new frontier. These deeper wells have encountered high-pressure, high-temperature (HPHT) conditions. Drilling in HPHT environments is the greatest technological and regulatory challenge to the oil and gas industry today. The basic building blocks of structural integrity are being challenged. Metals that have been in use for many years now face unique environmental conditions. The MMS is working with industry to evaluate the risks and set limits to mitigate these potential hazards. The American Petroleum Institute (API) has formed a team to develop a Recommended Practice (RP) on HPHT wells. The RP is designed to be an "umbrella type" document that would guide the formulation of several other documents that address HPHT equipment.

The MMS is also sponsoring research and participating in internal and industry-related conferences to stay at the forefront of new technology and is actively involved in developing options that will best promote human safety and environmental integrity. As deepwater wells are drilled to greater and greater depths, they begin to encounter the same HPHT conditions that shallow-water wells see at greater drilling depths. The HPHT compounds the technological challenges faced in deepwater exploration and especially in deepwater completion and production. Consequently, there is tremendous potential for growth and development in the HPHT area.

The pipeline from a subsea completion to its host structure is commonly referred to as the tieback. The tieback length varies considerably with each development. Most subsea wells are located within 10 mi (16 km) of their host platform. The Mensa field remains the current world record holder for a subsea tieback length of 62 mi (100 km) from its host. The second longest subsea tieback in the world (55 mi or 88 km) is Canyon Express, linking Aconcagua, Camden Hills, and King's Peak projects to their host platform. The number of long tiebacks is likely to increase as the industry moves into ever-deepening water depths with limited infrastructure to support the new development. The real key to making these extended tiebacks work lies in flow assurance. Industry has used pipe-in-pipe flowlines to insulate the production for the cold water and seabed. Cold temperatures can foster hydrate formation in the pipelines particularly if flow within the pipeline is diminished. Likewise, colder temperature can cause other problems, e.g., paraffinic deposition within the line. Chemicals may be added to the flow stream to enhance flow assurance. Industry is also examining sources of heat to maintain flow within the pipelines. Long tiebacks require long control umbilicals. The umbilicals control the wells and also provide conduits between the host and the subsea well for chemical treatments. For example, hydrate, corrosion, scale, and paraffin inhibitors may be transported to the well for injection via the well's umbilical.

The longer subsea tiebacks being used to develop marginal deepwater fields pose another challenge for industry, namely in the design and installation of pipelines rated for the HPHT well's shut-in tubing pressure (SITP) of 15,000 pounds per square inch (psi) and/or 350^{o} F (177^{o} C). Rather than relying on the physical strength of steel to withstand the SITP, a high-integrity pressure protection system (HIPPS) provides alternate overpressure protection for a pipeline or flowline. The HIPPS employs valves, logic controllers, and pressure transmitters to shut down the system before a pipeline is overpressured and/or ruptured.

The MMS has been working with the API and DeepStar to formulate the regulatory framework for the installation of an HIPPS in the GOM. DeepStar is a joint industry technology development project representing large and mid-size operators to help address common deepwater business challenges. DeepStar is expected to finish its HIPPS study in 2006, and API will address HIPPS in its *Recommended Practice API RP 17 O* in late 2006 or early 2007. However, it is anticipated that the GOM Region will receive applications for the use of an HIPPS in 2006.

Production hubs, e.g., Independence Hub, may find an increasing role in development in the GOM. Multiple fields using subsea technology may be connected to a centrally located production hub to facilitate the project's development. Fields that are considered marginal to produce may be developed through the economy of scale offered by this type of host.

New operational techniques such as managed pressure drilling (MPD) will facilitate exploration and development activities by allowing lessees to drill wells not previously considered possible. The MPD is a drilling methodology that has returns to the surface using an equivalent mud weight. Basically a combination of static mud weight, equivalent circulating densities, and surface back pressure maintained at or above open-hole pore pressure.

New types of material are likely to be proposed and used for risers. Composite materials may be substituted in part or in whole for conventional steel risers. As operations move into ever-deepening water depths, the weight of risers will also increase using conventional technology. Composite material may be used to lessen this weight-bearing requirement while maintaining the same level of safety afforded by the conventional steel risers. Riser configurations may also change. Equipment, including buoyant cells, may be affixed to lessen loads on rigs and production facilities.

Subsea processing is expected to enhance production from subsea wells. The overall process considers various types of liquid/gas separation, produced-water disposal, and subsea booster pumps. This technology will enable operators to produce lower pressure wells in greater water depths with increased distance to the "host" facility by reducing the volume of fluids and increasing the pressure in the flowline. Subsea processing is also expected to increase the recoverable reserves from the reservoirs, especially in ultra-deepwater.

Rig stationkeeping and survivability issues developed during the 2005 hurricane season. The MMS has addressed many of these concerns in two recently published NTL's (NTL's 2006-G09 and 2006-G10). These NTL's highly recommend that lessees and operators follow the recommendations of API RP 95J (for jack-up rigs) and API RP 95F (for floating rigs). Rig owners are currently improving their mooring systems to minimize movement off station.

Ocean currents may disrupt offshore operations and reduce the working life of certain equipment. In an effort to understand currents in the GOM and to provide information for forecasting, hindcasting, and fatigue damage, MMS created a program to monitor currents from all deepwater rigs and floating platforms. The MMS issued NTL 2005-G05, "Deepwater Ocean Current Monitoring on Floating Facilities," which requires operators to submit data in a standardized format to a publicly accessible website. This information is displayed real-time and can be downloaded for forecasting of currents and for historic reference. Operators are encouraged to use the information from nearby facilities, as well as their own, for daily operations and for determining damage caused by severe currents. In addition, site-specific data must be used in the design of new floating production facilities and drilling rigs, and their ancillary equipment, such as steel catenary risers and mooring systems.

Expandable tubulars may play an increasing part in future wells in the GOM. This technology allows tubulars (e.g., casing) to be installed in a well and then expanded to a larger internal diameter by forcing a specially designed tool down the tubular. The larger diameter tubular will allow installation of larger downhole equipment that may ultimately enhance production.

Synthetic-based drilling fluids (SBF) have also had a significant effect on exploration and development operations. A Department of Energy publication (USDOE, 1999) cites results from a GOM operator study that concluded that SBF significantly outperformed water-based fluids (WBF). Of eight wells drilled under comparable conditions to the same depth, the study found that the three wells drilled using SBF were completed in an average of 53 days at a cost of approximately $5.5 million. In comparison, the five wells drilled using WBF were completed in an average of 195 days at a cost of approximately $12.4 million. The environmental benefits from the use of SBF include reduced air emissions because of shorter drilling times and less waste because SBF are reconditioned and recycled.

New types of drilling fluid are expected to be developed to handle the harsh conditions encountered in HPHT wells. Some drilling fluid companies are in the process of examining alternative formulas for their products. Issues of concern will be the compatibility of the drilling fluid and the residual left on the cuttings when discharged into the environment.

Deepwater Operations Plans

Deepwater Operations Plans (DWOP's) are required of all deepwater development projects in water depths ≥1,000 ft (305 m) and for all projects proposing subsea production technology. The DWOP is designed to address industry and MMS concerns by allowing an operator to know, well in advance of significant spending, that their proposed methods of dealing with situations not specifically addressed in the regulations are acceptable to MMS. The DWOP provides MMS with information specific to deepwater/subsea equipment issues to demonstrate that a deepwater project is being developed in an acceptable manner. The MMS will review deepwater development activities from a total system perspective, emphasizing the operational safety, environmental protection, and conservation of natural resources. The DWOP was established through the NTL process, which provides for a more timely and flexible approach to keep pace with the expanding deepwater operations and subsea technology. On August 30, 2005, the DWOP requirements were incorporated into MMS operating regulations via revisions to 30 CFR 250 Subpart B.

A conceptual DWOP is required initially and is usually followed by a Development Operations Coordination Document (DOCD).

Development Operations and Coordination Document

The chief planning document that lays out an operator's specific intentions for development is the DOCD. Requirements for lessees and operators submitting a DOCD are addressed in 30 CFR 250.241-250.242, and information guidelines for DOCD's are given in NTL's 2006-G14 and 2006-G15.

WPA Proposed Action Scenario: It is estimated that 155-221 development wells will be drilled as a result of a proposed action in the WPA between 2007 and 2046. **Table 4-2** shows the estimated range of development wells by water-depth subarea. Approximately 47-50 percent of the projected wells are expected to be on the continental shelf (0-200 m (656 ft) water depth) and 50-53 percent are expected in intermediate water-depth ranges and deeper (>200 m (656 ft)). Trends between the oil and gas development wells are markedly different. For oil wells (51-76), the intermediate water-depth ranges and deeper (>200 m (656 ft)) has the largest portion of projected oil wells, 88-97 percent. For gas wells (105-146), the continental shelf (0-200 m (0-656 ft) water depth) has the largest portion of projected gas wells, about 66-68 percent.

CPA Proposed Action Scenario: It is estimated that 330-468 development wells will be drilled as a result of a proposed action in the CPA between 2007 and 2046. **Table 4-3** shows the estimated range of development wells by water-depth subarea. Approximately 20-25 percent of the projected wells are expected to be on the continental shelf (0-200 m (0-656 ft) water depth) and 75-80 percent are expected in intermediate water-depth ranges and deeper (>200 m (656 ft)). For gas development wells (162-223), 31-37 percent of those projected are on the continental shelf (0-200 m (0-656 ft) water depth) and 64-69 percent are in intermediate water-depth ranges and deeper (> 200 m (656 ft)). For oil development wells (168-245), 10-13 percent are on the continental shelf (0-200 m (0-656 ft) water depth) and 87-90 percent are in intermediate water-depth ranges and deeper (> 200 m (656 ft)).

OCS Program Scenario: It is estimated that 8,160-9,662 development wells will be drilled in the WPA and 23,181-26,243 in the CPA as a result of the Gulfwide OCS Program. **Tables 4-4, 4-5, and 4-6** shows the estimated range of development wells by water depth.

4.1.1.3.2. Infrastructure Emplacement/Structure Installation and Commissioning Activities

Bottom-founded or floating structures may be placed over development wells to facilitate production from a prospect. These structures provide the means to access and control the wells. They serve as a staging area to process and treat produced hydrocarbons from the wells, initiate export of the produced hydrocarbons, conduct additional drilling or reservoir stimulation, conduct workover activities, and carry out eventual abandonment procedures. There is a range of offshore infrastructure installed for hydrocarbon production. Among these are pipelines, fixed and floating platforms, caissons, well protectors, casing, wellheads, and conductors.

Subsea wells may also be completed to produce hydrocarbons from on the shelf and in the deepwater portions of the GOM. The subsea completions require a host structure to control their flow and to process their well stream. Control of the subsea well is accomplished via an umbilical from the host.

Pipelines are the primary means of transporting produced hydrocarbons from offshore oil and gas fields to distribution centers or onshore processing points. Pipelines range from small-diameter (generally 4-12 in) gathering lines, sometimes called flowlines, that link individual wells and production facilities to large-diameter (as large as 36 in) lines, sometimes called trunklines, for transport to shore. There are currently over 34,600 mi (54,718 km) of active pipelines on the GOM OCS. Pipelines are installed by lay barges that are either anchored or dynamically-positioned while the pipeline is laid. Pipeline sections may be welded together on a conventional lay barge as it moves forward on its route or they may be welded together at a fabrication site onshore and wound onto a large-diameter spool or reel. Once the reel barge is on location, the pipeline is straightened and lowered to the seafloor on its intended route. Both types of lay barge use a stinger to support the pipeline as it enters the water. The stinger helps to prevent undesirable bending or kinking of the pipeline as it is installed. In some cases, pipelines or segments of pipelines are welded together onshore or along a beach front area and then towed offshore to their location for installation.

Fixed, jacketed platforms are the most common surface structure of the GOM, with 1,926 units located on the shallow continental shelf, accounting for about 60 percent of all bottom-founded surface structures. Fixed platforms are brought on location as a complete unit or in sections on an installation barge towed by powerful tug boats. If the structure is fabricated in sections, it is generally composed of two segments called the jacket (the lower portion) and the deck (the portion above the water line). Accidents have occurred during the vulnerable period when heavy equipment is held only by cranes. In December 1998 the 3,600-ton topside structure for the Petronius compliant tower was lost in 533 m (1,750 ft) of water as it was being lifted into place by the lift barge in Viosca Knoll Block 892.

The platform’s tubular-steel jacket is then launched from the barge, upended, and lowered into position by a derrick barge with a large crane. The jacket is anchored to the seafloor by piles driven through the legs. The deck section with one or more levels is then lifted atop the jacket and welded to the foundation. The platform may have a helipad installed on its deck section. Platforms may or may not be manned continuously. The different types of floating platforms are discussed in the previous section.

Caissons are the second most numerous surface structures in the GOM, with over 1,071 units, accounting for about 30 percent of all bottom-founded, surface structures. Caissons are located primarily on the shallow continental shelf. Simpler in design and fabrication than traditional jacketed platforms, most caissons consist of a steel pipe that generally ranges from 36 to 96 in (91 cm to 2.44 m) in diameter. The caisson pipe is driven over existing well(s) to a depth that allows for shoring against varying sea states. Though primarily installed for well protection, some caissons may also be used as foundations for equipment and termination or relay points for pipeline operations.

Well protectors account for about 10 percent of all bottom-founded surface structures in the GOM. There are currently over 411 well protectors on the shallow continental shelf. Well protectors are used primarily to safeguard producing wells and their production trees from boat damage and from battering by floating debris and storms. Similar to fixed platforms, well protectors consist of small piled jackets with three or four legs generally less than 36 in (91 cm) in diameter, which may or may not support a deck section.

Structure installation and commissioning activities may take place over a period of a week to a month at the beginning of a platform's 20- to 40-year production life. The time required to complete the myriad of operations to start production at a structure is dependent on the complexity of its facilities.

To keep floating structures on station, a mooring system must be designed and installed. Lines to anchors or piling arrays attach the floating components of the structure. With a TLP, tendons stem from a base plate on the sea bottom to the floating portion of the structure. Commissioning activities involve the emplacement, connecting, and testing of the structure's modular components that are assembled on site.

WPA Proposed Action Scenario: It is estimated that 28-41 production structures will be installed as a result of a WPA proposed action. **Table 4-2** shows the projected number of structure installations for a WPA proposed action by water-depth range. About 80-82 percent of the production structures installed for a proposed action in the WPA are projected to be on the continental shelf (0-200 m, 0-656 ft). Approximately 18-20 percent of the structures are projected in intermediate water-depth ranges and deeper (>200 m, 656 ft).

CPA Proposed Action Scenario: It is estimated that 28-39 production structures will be installed as a result of a CPA proposed action. **Table 4-3** shows the projected number of structure installations for a CPA proposed action by water-depth range. About 62-79 percent of all the production structures installed for a proposed action in the CPA are projected to be on the continental shelf (0-200 m, 0-656 ft). Approximately 21-38 percent of the structures are projected in intermediate water-depth ranges and deeper (>200 m, 656 ft)).

OCS Program Scenario: It is estimated that 830-922 production structures would be installed in the WPA and 2,128-2,340 production structures would be installed in the CPA during 2007-2046. **Tables 4-5 and 4-6** show the projected number of structure installations by water-depth range for the OCS Program and planning areas. In the WPA, 89-92 percent of all the production structure installations are estimated for the continental shelf (0-200 m, 0-656 ft) and 8-11 percent in intermediate water-depth ranges and deeper (>200 m, 656 ft). In the CPA, 93-95 percent of all the production structure installations are estimated for the continental shelf (0-200 m, 0-656 ft) and 5-7 percent of the structures are projected in intermediate water-depth ranges and deeper (>200 m, 656 ft).

4.1.1.3.2.1. Bottom Area Disturbance

Structures emplaced or anchored on the OCS to facilitate oil and gas exploration and production include drilling rigs or MODU's (jack-ups, semisubmersibles, and drillships), pipelines, and fixed surface, floating, and subsea production systems described above. The emplacement or removal of these structures disturbs small areas of the sea bottom beneath or adjacent to the structure. If mooring lines of steel, chain, or synthetic polymer are anchored to the sea bottom, areas around the structure can also be directly affected by their emplacement. This disturbance includes physical compaction or crushing beneath the structure or mooring lines and the resuspension and settlement of sediment caused by the activities of emplacement. Movement of floating types of facilities will also cause the movement of the mooring lines in its array. Small areas of the sea bottom will be affected by this kind of movement. Impacts from bottom disturbance are of concern near sensitive areas such as topographic features, pinnacles, low-relief live-bottom features, chemosynthetic communities, high-density biological communities in water depths ≥400 m (1,312 ft), and archaeological sites.

Jack-up rigs are used in shallow water and disturb approximately 1 ha (2.5 acres (ac)) for each set up. Semisubmersibles can be operated in a wide range of water depths, and disturb about 2-3 ha (5-7 ac), depending on their mooring configurations. In water depths >600 m, dynamically-positioned (DP) drillships could be used; these drillships disturb only a very small area where the bottom template and wellbore are located, approximately 0.25 ha (0.62 ac). Since the advent of synthetic mooring lines, some drillships may be moored to the bottom. Drillships would affect an area of the bottom similar to that of the semisubmersibles, depending on their mooring array at their water depth.

Conventional, fixed platforms installed in water depths less than about 400 m (1,312 ft) disturb about 2 ha (5 ac) of the sea bottom. At water depths exceeding 400 m (1,312 ft), compliant towers, tension-leg platforms (TLP's), spars, and floating production systems (FPS's) would be used (**Figure 3-19**). A compliant tower would disturb the same bottom area—about 2 ha—as a conventional, fixed platform. A TLP consists of a floating structure held in place by tensioned tendons connected to the seafloor by pile-driven anchors. The bottom area disturbed by a TLP is dependent on the mooring line configuration and would be about 0.5 ha (1.2 ac) per anchor. A spar platform consists of a large-diameter cylinder supporting a conventional deck, three types of risers (production, drilling, and export), and a hull that is moored by a catenary system of 6-20 lines anchored to the seafloor. A spar would disturb about 1 ha (2.5 ac) of bottom area per mooring line, because mooring lines tend to be anchored farther away from the surface structure, which tends to cause more contact and scraping of the sea bottom near the anchor. Where applicable, a taut leg mooring system may be employed. This type of system exerts more tension on the mooring lines and results in fewer impacts to the seafloor.

A FPS or FPSO might be deployed in an area not serviced by pipelines. These systems consist of a semisubmersible or vessel anchored in place with mooring lines and that may be integrated with a floating storage system for produced oil. An FPS would disturb approximately 2-3 ha (5-7 ac) of sea bottom, depending on the number of wells produced, the number of mooring lines, and whether or not the system is anchored at all or is DP.

Subsea production systems located on the ocean floor are connected to surface topsides by a variety of components. These bottom-founded components are an integrated system of flowlines, manifolds, flowline termination sleds, umbilicals, umbilical sleds, blowout preventers, well trees, and production risers that disturb approximately 1 ha (2.5 ac) of sea bottom per well produced.

Emplacement of flowlines and export pipelines disturb between 0.5 ha (0.5 ac) and 1.0 ha (2.5 ac) of seafloor per kilometer of pipeline (Cranswick, 2001). The variation lies in the MMS requirement to bury pipelines in water depths <200 ft (61 m) to a depth of 3 ft (1 m). Burial is typically done by water jetting a trench followed by placing the pipeline into it. **Chapter 4.1.1.8.1** states about half of the new pipeline length installed as a result of a WPA proposed action, CPA proposed action, or the OCS Program would be in water depths <200 ft (61 m) requiring burial.

4.1.1.3.2.2. Sediment Displacement

Displaced sediments are those that have been physically moved "in bulk." Displaced sediments will cover or bury an area of the seafloor, while resuspended sediments will cause an increase in turbidity of the adjacent water column. Resuspended sediments eventually settle, covering the surrounding seafloor. Resuspended sediments may include entrained heavy metals or hydrocarbons.

The chief means for sediment displacement is the overboard discharge of drill cuttings carried to the surface and by drilling mud. Cuttings that outfall from surface platforms settle to the sea bottom as a mound or plume if influenced by the prevailing currents. Sediment displacement can also take place when anchored exploration rigs and production structures are subject to high current energy, such as GOM loop currents or hurricane sea states. Mooring lines in contact with the sea bottom can scrape sediment into heaps and mounds as the surface facility moves in response to currents.

Trenching for pipeline burial causes displacement or resuspension of seafloor sediments. The MMS's regulations (30 CFR 250.1003(a)(1)) require that pipelines installed in water depths <200 ft (61 m) are buried to a depth of at least 1 m (3 ft) below the mudline. Burying is required to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. It is assumed that 5,000 m^3 of sediment would be resuspended and an area of approximately 1 ha (2.5 ac) would be disturbed for each kilometer of pipeline requiring burial.

Sediment displacement also occurs as a result of the removal of pipelines. It is projected that the number of pipeline removals (or relocations) will increase Gulfwide as the existing pipeline infrastructure ages. For each kilometer of pipeline removed in water depths <200 ft (61 m), approximately 5,000 m^3 of sediment would be displaced and resuspended.

4.1.1.3.3. Infrastructure Presence

4.1.1.3.3.1. Anchoring

Most exploration drilling, platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, topside structures, or support vessels in place. These anchors disturb the seafloor and sediments of the area. Anchoring can cause physical compaction beneath the anchor and associated chains or lines, as well as resuspend sediment. Dynamically positioned rigs, production structures, and vessels are held in position by four or more propeller jets and do not cause anchoring impacts.

Conventional pipelaying barges use an array of eight 9,000-kg (19,842-lb) anchors to position the barge and to move it forward along the pipeline route. These anchors are continually moved as the pipelaying operation proceeds. The area actually affected by these anchors depends on water depth, wind, currents, chain length, and the size of the anchor and chain.

Mooring buoys may be placed near drilling rigs or platforms so that service vessels need not anchor, especially in deeper water. These temporarily installed anchors will most likely be smaller and lighter than those used for vessel anchoring and, thus, will have less impact on the sea bottom. Moreover, installing one buoy will preclude the need for numerous individual vessel-anchoring occasions. Service-vessel anchoring is assumed not to occur in water depths >150 m (492 ft) and only occasionally in shallower waters (vessels would always tie up to a platform or buoy in water depths >150 m (492 ft)).

Barges are assumed to always tie up to a production system rather than anchor. Barges and other vessels are also used for both installing and removing structures. These vessels use anchors placed away from their location of work.

4.1.1.3.3.2. Space-Use Conflicts

During OCS operations, the areas occupied by seismic vessels, structures, anchor cables and safety zones are unavailable to commercial fishermen. In addition, OCS operations may pose a space-use conflict with potential dredging activities for sand and gravel extraction (**Chapter 4.1.3.2.2**).

Seismic surveys will occur in both shallow and deepwater areas of the proposed actions. Usually, fishermen are precluded from a very small area for several days during active seismic surveying. Exploratory drilling rigs spend approximately 40-150 days on-site and are a short-term interference to commercial fishing. A major bottom-founded production platform in water depths less than 450 m, with a surrounding 100-m (328-ft) navigational safety zone, requires approximately 6 ha (15 ac) of space. A bunkhouse structure requires about 4 ha (9 ac) and a satellite structure requires about 1.5 ha (3.7 ac) of space. Virtually all commercial trawl fishing in the GOM is performed in water depths less than 200 m (656 ft) (Louisiana Dept. of Wildlife and Fisheries, 1992). A total of 31.2 million ha (77 million ac) in the Western and Central Gulf is located in water depths of 200 m (656 ft) or less.

Longline fishing is performed in water depths greater than 100 m (328 ft) and usually beyond 300 m (984 ft). All surface longlining is prohibited in the northern DeSoto Canyon area (designated as a swordfish nursery area by the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries Service)). The longline closure area encompasses at least some part of 539 blocks in the CPA. Longline fishing will also probably be effectively precluded from blocks for miles around the closure area because of the great length of typical longline sets and time required for their retrieval.

In water depths greater than 450 m, production platforms will be compliant towers or floating structures (such as TLP's and spars); this is beyond the range of typical commercial bottom trawling. Even though production structures in deeper water are larger and individually will take up more space, there will be fewer of them compared to the great numbers of bottom-founded platforms in shallower water depths. The use of tanker-based FPSO's is also being considered by operators in the Gulf and up to three are projected to be used in both the WPA and CPA proposed actions in water depths >800 m (2625 ft). The U.S. Coast Guard (USCG) has not yet determined what size navigational safety zone will be required during offloading operations. Factoring in various configurations of navigational safety zones, other deepwater facilities may require up to a 500-m (1,640-ft) radius safety zone or 78 ha (193 ac) of space (USCG regulations, 33 CFR Chapter 1, Part 147.15). Production structures in all water depths have a life expectancy of 20-30 years. The MMS data indicate that the total area lost to commercial fishing due to the presence of production platforms has historically been and will continue to be less than 1 percent of the total area available.

Additionally, MMS identified several OCS blocks offshore Louisiana where dredging activities could occur in the future. The USEPA, Region 6 and the Louisiana Department of Natural Resources considered using sand from the Ship Shoal area for coastal barrier island protection project. The following list of OCS blocks offshore Louisiana have been identified where potential dredging activities could occur and are included and/or updated in MMS's Final Notice of Sale Package: Ship Shoal Blocks 87-89, 94, and 95; South Pelto Blocks 12-14, 18, and 19; West Delta Blocks 27 and 49; Eugene Island Blocks 10, 18-35, 37-69, and 71-93; and South Marsh Island, North Addition Blocks 207-222, 226-232, and 241-246.

Dredging of sand in these Ship Shoal, South Pelto, West Delta, Eugene Island, and South Marsh blocks and the associated presence of an ocean-going dredge vessel could present some use conflicts with commercial fishing should the blocks be occupied by dredging barges and associated transport infrastructure.

Proposed Action Scenario: A maximum of 246 ha (608 ac) (41 structures @ 6 ha (15 ac)) will be lost to commercial fishing as a result of a proposed action in the WPA, and 234 ha (578 ac) (39 structures @ 6 ha (15 ac)) for a proposed action in the CPA. This is approximately 0.001 percent of the total area available in the sale areas. Considering that virtually all trawling occurs in water depths of less than 200 m (656 ft), the maximum area lost to trawling is only about 30 percent of the total due to the majority of activity being in deeper water.

The net effect on trawling will also be impacted by structure removals. In the majority of cases, structures removed in water depths less than 200 m (656 ft) will be taken to shore, resulting in trawl area being opened up. Even when platforms are transported to designated artificial reef planning areas, which already effectively prevent trawling, the net effect would again be additional trawling area. With platform removals included in the determination, the effective net area loss due to additional platforms is eight platforms added to the WPA and four platforms added to the CPA representing a total of 72 ha (178 ac).

OCS Program Scenario: Total OCS production structure installation in the GOM has been estimated through the year 2046. The estimated number of platforms installed varies widely between offshore subareas (**Figure 4-1**). In the WPA, production structure installation ranges from a low of 5-9 platforms in depths greater than 2,400 m (7,874 ft) to a high range of 666-710 in the shallowest offshore subarea (to a depth of 60 m (197 ft)). The total number of installations for the WPA ranges from 830 to 922 for all depth ranges. Projected CPA installations range from 11 to 13 in a depth range between 200 and 400 m (656 and 1,312 ft) to a high of 1,529-1,613 structures in the shallowest water depth C0-60 western subarea. The total number of installations for the CPA ranges from 2,128 to 2,340 for all depth ranges. As identified oil and gas fields are developed and fewer new reservoirs are located, the overall annual rate of platform and structure installation will decrease. Platform removal rates are expected to increase as mature fields are depleted. The rate of platform removal is projected to average between 150 and 152 structures per year. The trend of increased area lost to commercial fishing will be reversed over time as the rate of platform removals exceeds the rate of platform installation. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms will continue to be less than 0.1 percent of the total area available to commercial fishing.

4.1.1.3.3.3. Aesthetic Interference

The factors that could adversely affect the aesthetics of the coastline are oil spills and residue, tarballs, trash and debris, noise, pollution, increased vessel and air traffic, and the presence of drilling and production platforms visible from land. Oil spills, oil residue from tankers cleaning their holding tanks, and tarballs could affect beaches, wetlands, and coastal residences. Increased vessel and air traffic may result in additional noise or in oil and chemical pollution of water in ports and out at sea. The potential visibility of fixed structures in local GOM waters is worrisome for local chambers of commerce and tourist organizations. In a study conducted by the Geological Survey of Alabama (GSA) in 1998, several facets of the visibility of offshore structures were analyzed. The GSA earth scientists found that visibility is dictated not only by size and location of the structures and curvature of the Earth but also by atmospheric conditions. Social scientists added factors, such as the viewer's elevation (ground level, in a

2-story house, or in a 30-story condominium) and the viewer's expectations and perceptions. The size of an offshore structure depends on the reservoir being tapped, characteristics of the well-stream fluid, and the type of processing needed to treat the hydrocarbons. Location reflects the geology of the reservoir. Optimal location of structures means at or near the surface above the reservoir (GSA, 1998). Atmosphere refers to conditions of weather, air quality, and the presence or absence of fog, rain, smog, and/or winds. The height of the viewer affects their ability to see and distinguish objects several yards or miles away. Perceptions often dictate what people expect to see and, hence, what they do see.

To test visibility in as scientific a way as possible, GSA staff worked with members of the Offshore Operators Committee. They took a series of photographs on one day in October 1997, from a helicopter hovering at 300 ft. They used the same camera, lens, shutter speed, and f-stop setting. The subjects of the photos were four different types of structures usually found in both State and Federal waters offshore Alabama. The structures ranged in height from 60 to 70 ft; they varied in size from 120 ft by 205 ft to 40 ft by 90 ft with the smallest being 50 ft by 80 ft. The tallest and widest structures, i.e., those showing the most surface in the viewscape, were visible at up to 5 mi from shore. The shorter and the smaller the structure, the less visible at 5 mi; the smallest could barely be seen at 3 mi from shore. According to this study, no structure located more than 10 mi offshore would be visible (GSA, 1998).

The WPA is 10.4 mi from Texas; therefore, no structures located in the WPA would be visible from shore. The CPA is 3 nmi from Louisiana, Mississippi, and Alabama. In the CPA, there are nearly 1,000 platforms (34% of structures in less than 60 m (197 ft)) within 10 mi of the coast.

Additional IPF's associated with offshore oil and gas activities are oil spills and trash and debris. These are the most widely recognized as major threats to the aesthetics of coastal lands, especially recreational beaches. These factors, individually or collectively, may adversely affect the fishing industry, resort use, and the number and value of recreational beach visits. The effects of an oil spill on the aesthetics of the coastline depend on factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods (if any).

Proposed Action Scenario: Because of the distance to shore, no structures installed as result of a WPA proposed action would be visible from shore. Of the structures projected to be installed in 0-60 m (0-197 ft) as a result of a CPA proposed action (**Table 4-3**), seven (34%) would be located within 10 mi of the coast.

OCS Program Scenario: Because of the distance to shore, no structures in the WPA would be visible from shore. Of the structures projected to be installed in 0-60 m (0-197 ft) as a result of the OCS Program in the CPA (**Table 4-6**), 612-645 (34%) would be located within 10 mi from shore.

4.1.1.3.3.4. Bottom Debris

Bottom debris is defined as material resting on the seabed (such as cable, tools, pipe, drums, anchors, and structural parts of platforms, as well as objects made of plastic, aluminum, wood, etc.) that are accidentally lost (e.g., during hurricanes) or tossed overboard from fixed or floating facilities. The maximum quantity of bottom debris per operation is estimated to be several tons. The MMS requires site clearance over the assumed areal extent over which debris will fall. **Chapter 4.1.1.11** describes the requirements and guidelines for removing bottom debris and gear after structure decommissioning and removal operations. There are also requirements for verification that operational debris has been removed from the areas around the platform removal site (e.g., by trawling the area to verify that the site has, in fact, been cleared of debris).

The Fishermen's Contingency Fund (FCF) was established to provide recourse for recovery of commercial fishing equipment losses due to entanglement on OCS oil and gas structures and debris. Direct payments for claims in FY 2003 totaled $107,989 and total payments for FY 2004 were $187,429 (USDOC, NOAA Fisheries Service, Office of Management and Budget, 2006).

Proposed Action Scenario: It is assumed that most of the future lost debris will be removed from the seafloor during the structure decommissioning, site clearance, and verification process.

OCS Program Scenario: It is assumed that most of the future lost debris will be removed from the seafloor during the structure decommissioning, site clearance, and verification process.

4.1.1.3.4. Workovers and Abandonments

Completed and producing wells may require periodic reentry that is designed to maintain or restore a desired flow rate. These procedures are referred to as a well "workover." Workover operations are also carried out to evaluate or reevaluate a geologic formation or reservoir (including recompletion to another strata) or to permanently abandon a part or all of a well. Examples of workover operations are acidizing the perforated interval in the casing, plugging back, squeezing cement, milling out cement, jetting the well in with coiled tubing and nitrogen, and setting positive plugs to isolate hydrocarbon zones. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from 1 day to several months to complete depending on the complexity of the operations, with a median of 7 days. Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. On the basis of historical data, MMS projects a producing well may expect to have seven workovers or other well activities during its lifetime.

There are two types of well abandonment operations—temporary and permanent. An operator may temporarily abandon a well to (1) allow detailed analyses or additional delineation wells while deciding if a discovery is economically viable, (2) save the wellbore for a future sidetrack to a new geologic bottom-hole location, or (3) wait on design or construction of special production equipment or facilities. The operator must meet specific requirements to temporarily abandon a well (30 CFR 250.703). Permanent abandonment operations are undertaken when a wellbore is of no further use to the operator (i.e., the well is a dry hole or the well's producible hydrocarbon resources have been depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well that contain hydrocarbons are plugged with cement. A cement surface plug is also required for the abandoned wells. This serves as the final isolation component between the wellbore and the environment.

WPA Proposed Action Scenario: **Table 4-2** shows there are 945-1,344 workovers projected as a result of a WPA proposed action. The projected number of workovers is a function of producing wells, including one permanent abandonment operation per well.

CPA Proposed Action Scenario: **Table 4-3** shows there are 2,009-2,849 workovers projected as a result of a CPA proposed action. The projected number of workovers is a function of producing wells, including one permanent abandonment operation per well.

OCS Program Scenario: **Table 4-4** shows there are 190,778-218,555 workovers projected Gulfwide as a result of the OCS Program. Of these, 26-27 percent would be in the WPA and 73-74 percent would be in the CPA. The projected number of workovers is a function of producing wells including one permanent abandonment operation per well.

4.1.1.4. Operational Waste Discharged Offshore

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced water, produced sand and well treatment, workover, and completion (TWC) fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, several fluids used in subsea production, and uncontaminated freshwater and saltwater.

The USEPA, through general permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities. The USEPA published the effluent guidelines for the offshore oil and gas extraction point-source category in 1993 (58 FR 12454). Synthetic-based fluids (SBF) were first used in the GOM in 1992 and effluent guidelines limitations for SBF were published January 22, 2001. The USEPA Region 4 has jurisdiction over the eastern portion of the GOM OCS including all of the EPA and a portion of the CPA off the coasts of Alabama and Mississippi (**Figure 4-3**). The USEPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA.

Each USEPA Region has promulgated general permits for discharges that incorporate the 1993 effluent guidelines and 2000 effluent guidelines for SBF-wetted cuttings as a minimum. The current Region 4 general permit (GMG460000) was issued on December 9, 2004, became effective January 1, 2005, and expires on December 31, 2009 (USEPA, 2004d). It was preceded by the permit (GMG280000) issued October 16, 1998, modified March 14, 2001, and expired on October 31, 2003.

The current Region 6 general permit (GMG290000) reissuance was announced October 7, 2004, became effective November 6, 2004, and will expire on November 5, 2007 (USEPA, 2004e). This permit is unusual in that it was issued for only three years because it included additional data collection requirements on the hypoxic zone. The permit was previously issued on November 2, 1998, was modified on April 19, 1999, and again on February 16, 2002, to reflect new guidelines for the discharge of SBF. A history of the USEPA Region 6 permit is available on the USEPA website at http://www.epa.gov/Arkansas/6en/w/offshore/home.htm.

4.1.1.4.1. Drilling Muds and Cuttings

The largest quantity of discharge generated by drilling operations is drilling fluids (also known as drilling muds) and cuttings. Drilling fluids are used in rotary drilling to remove cuttings from beneath the bit, to control well pressure, to cool and lubricate the drill string and its bit, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid. Drilling discharges of muds and cuttings are regulated by USEPA through an NPDES permit.

The composition of drilling fluids is complex. Drill cuttings are a different grain size and composition from the existing surface sediments. Drilling fluids used on the OCS are divided into two categories: water based and nonaqueous based, in which the continuous phase is not soluble in water. Clays, barite, and other chemicals are added to the base fluid, which can be freshwater or saltwater in water-based fluids or mineral, diesel oil, or synthetic oil in nonaqueous based fluids. Additional chemicals are added to improve the performance of the drilling fluid (Boehm et al., 2001).

Water-based drilling fluids (WBF) have been used for decades in drilling on the OCS. The WBF may have mineral oil added for lubricity. The discharge of WBF and cuttings associated with WBF is allowed almost everywhere on the OCS under the general NPDES permits issued by USEPA Regions 4 and 6, as long as the discharge meets guidelines. Individual permits may also be obtained.

Discharge of WBF results in increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and trace metals. Occasionally, formation oil may be discharged with the cuttings, adding hydrocarbons to the discharge. In shallow environments, WBF are rapidly dispersed in the water column immediately after discharge and rapidly descend to the seafloor (Neff, 1987). In deep waters, fluids dispersed near the water surface would disperse over a wider area than fluids dispersed in shallow waters.

The early nonaqueous drilling fluids, termed oil-based drilling fluids (OBF), were occasionally used for directional drilling and in drill-bore sections where additional lubricity was needed. Crude, diesel, and mineral oil were used. Diesel OBF contains light aromatics such as benzene, toluene, and xylene, and mineral oil was advantageous over diesel because it was less toxic. Hydrocarbon concentration and impacts to benthic community diversity and abundance have been observed within 200 m (656 ft) of the drill site with diminishing impacts measured to a distance of 2,000 m (6,562 ft) (Neff, 1987). All OBF and associated cuttings must be transported to shore for recycling or disposal unless reinjected. All OBF are likely to be replaced by SBF in deepwater drilling because of the many advantageous features of SBF (Neff et al, 2000).

The SBF are manufactured hydrocarbons. Since the SBF are not petroleum based, they do not contain the aromatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH) that contributed to OBF toxicity and persistence on the seafloor (OGP, 2003). The SBF mud system also contains additives such as emulsifiers, clays, wetting agents, thinners, and barite. Since 1992, SBF have been increasingly used, especially in deepwater, because they perform better than WBF and OBF. The SBF reduce drilling times and costs incurred from expensive drilling rigs. By 1999, about 75 percent of all wells drilled in waters deeper than 305 m (1,000 ft) were drilled with SBF in the GOM (CSA, 2004). Although there are many types of SBF, internal olefins and linear alpha olefins are most commonly used in the GOM.

A literature review (Neff et al., 2000) discusses the current knowledge about the fate and effects of SBF discharges on the seabed. Like OBF, SBF are hydrophobic, do not disperse in the water column and therefore are not expected to adversely affect water quality. The SBF-wetted cuttings settle close to the discharge point and affect the local sediments. Cuttings piles with a maximum depth of 8-10 in (20-25 cm) were noted in a seabed study of shelf and slope locations where cuttings drilled with SBF were discharged. The primary effects are smothering of the benthic community, alteration of sediment grain size, and addition of organic matter, which can result in localized anoxia during the time it takes the SBF to degrade (Melton et al., 2004). Different formulations of SBF use base fluids that degrade at different rates, thus affecting the duration of the impact. Esters and olefins are the most rapidly biodegraded SBF.

Bioaccumulation tests indicate that SBF and their degradation products should not bioaccumulate (Neff et al., 2000). In a study to measure degradation rates of SBF on the seafloor and to characterize the microbial populations, the sulfate-reducing bacterial counts increased in sediments incubated with SBF under deep-sea conditions (Roberts and Nguyen, 2006). Biodegradation proceeded after a lag period of up to 28 weeks influenced by both the SBF type and prior exposure of the sediments to SBF. Sulfate depletion in the test sediments because of microbial activity coincided with SBF degradation. Incubation at atmospheric pressure or high pressure did not affect the rate of biodegradation. In the joint industry study required as part of the USEPA Region 6 NPDES permit, sediment recovery was noted during the 1-year interval between the first and second sample collection as indicated by a decrease in SBF concentrations. Deposited cuttings and measurable sediment effects indicative of organic enrichment were concentrated within 250 m (820 ft) distance in both shelf and slope sites (CSA, 2004). The SBF concentrations in sediments at drill locations contained average internal olefin SBF concentrations of 500 to 13,000 parts per million (ppm) on the shelf and concentrations of 2,000 to 11,750 ppm on the slope, one to four (1-4) years after discharge.

The discharge of the base SBF drilling fluid is prohibited. The SBF and the cuttings must meet environmental requirements. Both USEPA Regions permit the discharge of cuttings wetted with SBF as long as the retained SBF amount is below a prescribed percent, meets biodegradation and toxicity requirements, and is not contaminated with the formation oil or PAH.

Typically, the upper portion of the well is drilled with WBF to a depth in the range of 800-2,000 m (2,625-6,562 ft) and, following "switchover," the remainder is drilled with SBF. The upper sections would be drilled with a large diameter bit; progressively smaller drill bits are used with increasing depth. Therefore, the volume of cuttings per interval (length of wellbore) in the upper section of the well would be greater than the volume generated in the deeper sections.

Barite, barium sulfate, is used as a weighting agent and is a major component of all drilling fluid types. The amount of barite discharged from 81 wells during 1998 to 2002 was estimated because the quantity of barite used has declined with advances in SBM technology and drilling. The quantity of barite discharged for a shallow well (3,962 m or 13,000 ft) to a deep well (6,400 m or 21,000 ft) is 110 tons barite per well and 586 tons barite per well, respectively (Candler and Primeaux, 2003).

A comparative study of surface and subsurface sediment samples from six offshore drill locations showed higher levels of total mercury found in the sediments closest to the drilling sites as compared with the sites greater than 3 km (1.9 mi) distant. The higher total mercury concentrations corresponded to the higher barium concentrations also present. The higher total mercury levels in nearfield sediments did not translate to higher methylmercury concentration in those sediments, with a few exceptions (Trefrey et al., 2002). Sediment redox conditions and organic content influence methylmercury formation.

Atmospheric mercury deposition is believed to be the main source of anthropogenic mercury inputs into the marine environment. However, mercury in fish tissue is a concern and mercury in barite has been suggested as a secondary source in the GOM. Mercury and other trace metals are naturally occurring impurities in barite. Since 1993, USEPA has required the concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make up drilling muds. Through mercury and cadmium regulation, USEPA can also control levels of other trace metals in barite. This reduces the addition of mercury to values similar to the concentration of mercury found in marine sediments throughout the GOM (Avanti Corporation, 1993a and b; USEPA, 1993a and b). Concentrations of total mercury in uncontaminated estuarine and marine sediments generally are 0.2 μg/g dry weight or lower. Surface sediments collected 20-2,000 m (66-6,562 ft) away from four oil production platforms in the northwestern GOM contained 0.044-0.12 μg/g total mercury. These amounts are essentially background concentrations for mercury in surficial sediments on the GOM OCS (Neff, 2002).

Barite is nearly insoluble in seawater, thus trapping mercury and other trace metals in the barite grains. Therefore, unless the mercuric sulfide in the barite can be microbially methylated, this source of mercury is relatively unavailable for uptake into the marine food web. The solubility of barite and the rate at which it dissolves (and thereby releases associated metals such as mercury), the amount of metals released from the barite, and the rate of dissolution of barite and release of metals after burial under simulated seafloor conditions was studied (Crecelius et al., in preparation). The research used three grades of barite: one commercially available barite ore used in drilling fluids, which meets USEPA acceptance criteria for trace metal content, and two grades of barite to represent those used in the GOM prior to the 1993 USEPA regulation enacted to reduce the concentrations of Hg and Cd in drilling fluid. The solubility of the associated mercury in seawater at two pH concentrations tended to increase with time for at least several months, but remained well below the USEPA water quality criterion. The studies conducted at varying pH levels to mimic digestive tract conditions showed that very little (less than 0.1%) of the Hg in barite became biologically available.

In an extensive survey conducted by NOAA Fisheries Service, seven species of reef fish were obtained at locations with extensive oil drilling, and thus barite, and were compared to reef fish obtained at locations with no drilling. No differences in mercury levels between the two groups were noted (Lowery and Garrett, 2005).

4.1.1.4.2. Produced Waters

Produced water is brought up from the hydrocarbon-bearing strata along with produced oil and gas. This waste stream can include formation water, injection water, well treatment, completion, and workover compounds added downhole and compounds used during the oil/water separation process. Formation water, also called connate water or fossil water, originates in the permeable sedimentary rock strata and is brought up to the surface commingled with the oil and gas. Injection water is water that was injected to enhance oil production and in secondary oil recovery.

In addition to the added chemical products, produced water contains chemicals that have dissolved into the water from the geological formation where the water was stored. The amount of dissolved solids can be more concentrated than is found in seawater. Produced water contains inorganic and organic chemicals and radionuclides (226Ra and 228Ra). The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds.

Both USEPA general permits allow the discharge of produced water on the OCS provided they meet discharge criteria. The produced water is treated to separate free oil from the water. Since the oil/water separation process does not completely separate all of the oil, some hydrocarbons remain with the produced water and often the water is treated to prevent the formation of sheen. Produced water may be discharged if the oil and grease concentration does not exceed 42 milligrams per liter (mg/l) daily maximum or 29 mg/l monthly average. The discharge must also be tested for toxicity. Both USEPA permits require no discharge within 1,000 m (3,281 ft) of an area of biological concern. Region 4 also requires no discharge within 1,000 m (3,281 ft) of any federally designated dredged material ocean disposal site. Region 4 permits the discharge of a smaller range of produced water volumes than Region 6.

The Region 6 NPDES permit required the Produced Water Hypoxia Study, in which produced water was collected from 50 platforms that discharge into the hypoxic zone and was analyzed for oxygen-demanding characteristics (Veil et al., 2005). The mean biochemical oxygen demand (BOD) was 957 mg/l, total organic carbon (TOC) was 564 mg/l, and total Kjeldahl nitrogen (TKN) was 83 mg/l in produced waters from the platforms located within the hypoxic zone. Samples from platforms that produced mostly gas had higher average BOD and TOC concentrations but smaller volumes than platforms that produced mostly oil. About 508,000 bbl/day produced water was generated per day in the hypoxic zone in 2003. The estimated BOD loading is 104,000 lb/day. In comparison to loadings from the Mississippi and Atchafalaya Rivers, the total nitrogen loading from produced water is about 0.16 percent and total phosphorus loading is about 0.013 percent of the nutrient loading coming from the rivers.

Estimates of the volume of produced water generated per well vary because the percent water is related to well age and hydrocarbon type. Usually, produced-water volumes are small during the initial production phase and increase as the formation approaches hydrocarbon depletion. Produced water volumes range from 2 to 150,000 bbl/day (USEPA, 1993a and b). In some cases, a centralized platform is used to process water from several surrounding platforms. Some of the produced water may be reinjected into the well. Reinjection occurs when the produced water does not meet discharge criteria or when the water is used as part of operations.

The MMS maintains records of the volume of water produced from each block on the OCS and its disposition—injected on lease, injected off lease, transferred off lease, or discharged overboard. At present, the quantity discharged overboard is about 93-99 percent of the total volume of produced water extracted. The amount dischared overboard for the years 1996-2005 is summarized by water depth in **Table 4-7** and the amount extracted is shown in **Figure 4-4**. The largest amount of produced water generated in this 10-year period was in 2001 on the shelf and the volume for all water depths in 2001 was 686 million bbl (MMbbl). In subsequent years, the amount of produced water generated on the shelf decreased to around 580 MMbbl. For the water depths 0-400 m (0-1,312 ft), the volume of produced water decreased by an average of 34 percent in 2004 and 2005, reflecting the damaging effects of the hurricanes. The majority of blocks where water is produced are on the continental shelf off the coast of Louisiana. Very little water is produced off the coast of Texas because these are primarily gas fields.

Deepwater (>400 m (1,312 ft) water depth) production is fairly recent and very little water is produced at this time. In 2003, 30 MMbbl of produced water was generated in deep and ultradeep water. Produced water generation and discharge in the 400- to >2,400-m (1,312- to >7,874-ft) water depth increased by about 50 percent from 2003 to 2005, but the volume is approximately 5 percent of the volume generated in shallower waters. The low temperature and high pressure conditions found in deepwater can result in flow problems such as hydrate formation in the lines. Additional quantities of chemicals are used to assure production, and even with recovery systems, some of these chemicals will be present in produced water (Regg et al., 2000). For deepwater operations, new technologies are being developed that may discharge or reinject produced water at the seafloor or at "minimal surface structures" before the production stream is transported by pipeline to the host production facility.

4.1.1.4.3. Well Treatment, Workover, and Completion Fluids

Wells are drilled using a base fluid and a combination of other chemicals to aid in the drilling process. Fluids (drilling muds) present in the borehole can damage the geologic formation in the producing zone. Completion fluids are used to displace the drilling fluid and protect formation permeability. "Clear" fluids consist of brines made from seawater mixed with calcium chloride, calcium bromide, and/or zinc bromide. These salts can be adjusted to increase or decrease the density of the brine to hold back-pressure on the formation. Additives, such as defoamers and corrosion inhibitors, are used to reduce problems associated with the completion fluids. Recovered completion fluids can be recycled for reuse.

Workover fluids are used to maintain or improve existing well conditions and production rates on wells that have been in production. Seven workovers are projected per producing well over their lifetime. Workover operations include casing and subsurface equipment repairs, re-perforation, acidizing, and fracturing stimulation. During some of the workover operations, the producing formation may be exposed, in which case fluids like the aforementioned completion fluids are used. In other cases, such as acidizing and fracturing (also considered stimulation or well treatment), hydrochloric (HCl) and other acids are used. Both procedures are used to increase the permeability of the formation. The acids dissolve limestone, sandstone, and other deposits. Because of the corrosive nature of acids, particularly when hot, corrosion inhibitors are added. Since the fluids are altered with use, they are not recovered and recycled; however, these products may be mixed with the produced water.

Production treatment fluids are chemicals applied during the oil and gas extraction process. Production chemicals are used to dehydrate produced oil or treat the associated produced water for reuse or disposal. A wide variety of chemicals are used including corrosion and scale inhibitors, bactericides, paraffin solvents, demulsifiers, foamers, defoamers, and water treatment chemicals (Boehm et al., 2001). Some of the production chemicals mix with the production stream and are transported to shore with the product. Other chemicals mix with the produced water. Most produced water cannot be discharged without some chemical treatment. Even water that is reinjected downhole must be cleaned to protect equipment. The types and volumes of chemicals that are used changes during the life of the well. In the early stages, defoamers are used. In the later stages, when more water than oil is produced, demulsifiers and water-treatment chemicals are used more extensively.

Both USEPA Regions 4 and 6 allow the discharge of well-treatment, completion, and workover fluids that meet the specified guidelines. Additives containing priority pollutants must be monitored. Some well treatment, workover, and completion chemicals are discharged with the drilling muds and cuttings or with the produced-water streams. Both must meet the general toxicity guidelines in the NPDES general permit. Discharge and monitoring records must be kept.

4.1.1.4.4. Production Solids and Equipment

As defined by USEPA in the discharge guidelines (58 FR 12454), produced sands are slurried particles, which surface from hydraulic fracturing, and the accumulated formation sands and other particles including scale, which is generated during production. This waste stream also includes sludges generated in the produced-water treatment system, such as tank bottoms from oil/water separators and solids removed in filtration. The guidelines do not permit the discharge of produced sand, which must be transported to shore and disposed of as nonhazardous oil-field waste according to State regulations. Estimates of total produced sand expected from a platform are from 0 to 35 bbl/day according to USEPA (1993a and b). A variety of solid wastes are generated including construction/demolition debris, garbage, and industrial solid waste. No equipment or solid waste may be disposed of in marine waters.

4.1.1.4.5. Deck Drainage

Deck drainage includes all wastewater resulting from platform washings, deck washings, rainwater, and runoff from curbs, gutters, and drains including drip pans and work areas. The USEPA general guidelines for deck drainage require that no free oil be discharged, as determined by visual sheen.

The quantities of deck drainage vary greatly depending on the size and location of the facility. An analysis of 950 GOM platforms during 1982-1983 determined that deck drainage averaged 50 bbl/day/platform (USEPA, 1993a and b). The deck drainage is collected, the oil is separated, and the water is discharged to the sea. Impacts from the discharge of deck drainage are assumed to be negligible for a proposed action.

4.1.1.4.6. Treated Domestic and Sanitary Wastes

Domestic wastes originate from sinks, showers, laundries, and galleys. Sanitary wastes originate from toilets. For domestic waste, no solids or foam may be discharged. In addition, the discharge of all food waste within 12 nmi from nearest land is prohibited. In sanitary waste, floating solids are prohibited. Facilities with 10 or more people must meet the requirement of total residual chlorine greater than 1 mg/l and maintained as close to this concentration as possible. There is an exception in both general permits for the use of marine sanitation devices.

In general, a typical manned platform will discharge 35 gallons per person per day of treated sanitary wastes and 50-100 gallons per person per day of domestic wastes (USEPA, 1993a and b). It is assumed that these discharges are rapidly diluted and dispersed; therefore, no analysis of the impacts will be performed for a proposed action.

4.1.1.4.7. Minor Discharges

Minor discharges include all other discharges not already discussed that may result during oil and gas operations. Minor or miscellaneous wastes include desalination unit discharge, blowout preventer fluid, boiler blowdown, excess cement slurry, uncontaminated freshwater and saltwater, and miscellaneous discharges at the seafloor, such as subsea wellhead preservation and production control fluid, umbilical steel tube storage fluid, leak tracer fluid, and riser tensioner fluids. In all cases, no free oil shall be discharged with the waste. Unmanned facilities may discharge uncontaminated water through an automatic purge system without monitoring for free oil. The discharge of freshwater or seawater that has been treated with chemicals is permitted providing that the prescribed discharge criteria are met. No projections of volumes or contaminant levels of minor discharges are made for a proposed action because the impacts are considered negligible.

4.1.1.4.8. Vessel Operational Wastes

The USCG defines an offshore service vessel (OSV) as a vessel propelled by machinery other than steam that is of more than 15 gross tons and less than 500 gross tons and that regularly carries goods, supplies, individuals in addition to the crew, or equipment in support of exploration, exploitation, or production of offshore mineral or energy resources (46 CFR 90.10-40). Operational waste generated from supply vessels that support oil and gas operations include bilge and ballast waters, trash and debris, and sanitary and domestic wastes.

Bilge water is water that collects in the lower part of a ship. The bilge water is often contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures is prohibited under 33 CFR 151.10; however, discharges may occur in waters greater than 12 nmi if the oil concentration is less than 100 ppm. Discharges may occur within 12 nmi, if the concentration is less than 15 ppm.

Ballast water is used to maintain stability of the vessel and may be pumped from coastal or marine waters. Generally, the ballast water is pumped into and out of separate compartments and is not usually contaminated with oil; however, the same discharge criteria apply as for bilge water (33 CFR 151.10).

The discharge of trash and debris is prohibited (33 CFR 151.51-77) unless it is passed through a comminutor and can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

All vessels with toilet facilities must have a marine sanitation device (MSD) that complies with 40 CFR 140 and 33 CFR 149. Vessels complying with 33 CFR 159 are not subject to State and local MSD requirements. However, a State may prohibit the discharge of all sewage within any or all of its waters. Domestic waste consists of all types of wastes generated in the living spaces on board a ship including gray water that is generated from dishwasher, shower, laundry, bath and washbasin drains. Gray water from vessels is not regulated in the GOM. Gray water should not be processed through the MSD, which is specifically designed to handle sewage.

4.1.1.4.9. Assumptions about Future Impacts from OCS Wastes

- The use of SBF will increase, replacing the use of OBF in most situations.
- New types of muds may be developed to address conditions in HPHT wells.
- The discharge of cuttings wetted with SBF (i.e., cuttings with drilling fluid adhered to the surface of the rock fragments) to the seafloor will reduce the volume of cuttings transported to shore for disposal.
- New technologies in deepwater may result in discharges at the seafloor, reducing the potential for water column impacts but increasing impacts at the seafloor.
- The movement into deepwater will result in fewer total platforms but greater volumes of discharges at each platform. Volumes of discharges may change in response to new deepwater technologies.

4.1.1.5. Trash and Debris

The OCS oil and gas operations generate trash and debris materials made of paper, plastic, wood, glass, and metal. Most of this trash is associated with galley and offshore food service operations and with operational supplies such as shipping pallets, containers used for drilling muds and chemical additives (sacks, drums, and buckets), and protective coverings used on mud sacks and drilling pipes (shrink wrap and pipe-thread protectors). Some personal items, such as hardhats and personal flotation devices, are accidentally lost overboard from time to time. Generally, galley, operational, and household trash is collected and stored on the lower deck near the loading dock in large receptacles resembling dumpsters. These large containers are generally covered with netting to avoid loss and are returned to shore by service vessels for disposal in landfills. Drilling operations require the most supplies, equipment, and personnel, and therefore, generate more solid trash than production operations.

The MMS regulations, USEPA's NPDES general permit, and USCG regulations implementing MARPOL 73/78 Annex V prohibit the disposal of any trash and debris into the marine environment. Victual matter or organic food debris may be ground up into small pieces and disposed of overboard from structures located more than 20 km (12 mi) from shore.

Over the last several years, companies have employed trash and debris reduction and improved handling practices to reduce the amount of offshore trash that could potentially be lost into the marine environment. Improved trash management practices, such as substituting paper and ceramic cups and dishes for those made of styrofoam, recycling offshore trash, and transporting and storing supplies and materials in bulk containers when feasible, are commonplace and have resulted in a marked decline in accidental loss of trash and debris.

4.1.1.6. Air Emissions

The OCS activities that use any equipment that burns/vents a fuel, that transports and/or transfers hydrocarbons, or that results in accidental releases of petroleum hydrocarbons or chemicals, causes emissions of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere.

The criteria pollutants considered here are nitrogen oxides (NO_x), carbon monoxide (CO), sulphur oxides (SO_x), volatile organic chemicals (VOC), and particulate matter 2.5-10 microns in size (PM_{10}) and less than 2.5 microns in size ($PM_{2.5}$). Criteria pollutant emissions from OCS platforms and nonplatform operations are shown in **Table 4-8**. These emissions are taken from the 2000 MMS emissions inventory of offshore OCS activities (Wilson et al., 2004).

Flaring is the venting and/or burning or releasing of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring, or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the wellbore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring/venting are included in the emissions tables and in the modeling analysis.

4.1.1.7. Noise

Noise associated with OCS oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and may be extended or transient. Offshore drilling and production involves various activities that produce a composite underwater noise field. The intensity level and frequency of the noise emissions are highly variable, both between and among the various industry sources. Noise from proposed OCS activities may affect resources near the activities. Whether a sound is or is not detected by marine organisms would depend both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause physical damage or death to an exposed animal; intense levels can damage hearing; and loud or novel sounds may induce disruptive behavior or other responses of lesser importance.

When the MMPA was enacted in 1972, the concept that underwater sounds of human origin could adversely affect marine mammals was not considered or recognized (MMC, 2002). Concern on the effects of underwater noise on marine mammals and the increasing levels of manmade noise introduced into the world's oceans has since become a major environmental issue (Jasny, 1999). It is generally recognized that commercial shipping is a dominant component of the ambient, low-frequency background noise in modern world oceans (Gordon and Moscrop, 1996) and that OCS-related, service-vessel traffic would contribute to this. For the GOM, that contribution to existing shipping noise is likely insignificant (USDOI, MMS, 2004). Another sound source more specific to OCS operations originates from seismic operations. Airguns produce an intense but highly localized sound energy and represent a noise source of possible concern. The MMS has completed a programmatic EA on G&G permit activities in the GOM (USDOI, MMS, 2004). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference.

Marine seismic surveys direct a low-frequency energy wave (generated by an airgun array) into the ocean floor and record the reflected energy waves' strength and return arrival time. The pattern of reflected waves, recorded by a series of hydrophones embedded in cables towed by the seismic vessel (streamers) or ocean bottom cables (OBC) placed on the ocean floor, can be used to "map" subsurface layers and features. Seismic surveys can be used to check for foundation stability, detect groundwater, locate mineral deposits (coal), and search for oil and gas. Most commercial seismic surveying is carried out for the energy sector (Gulland and Walker, 1998). Two general types of seismic surveys are conducted in the GOM relative to oil and gas operations. High-resolution site surveys collect data up to 1 km (0.6 mi) deep through bottom sediments and are used for initial site evaluation for potential structures as well as for exploration. This involves a small vessel and usually a single airgun source and is also usually restricted to small areas, most often a single lease site. Deep seismic surveys involve a larger "standard" survey vessel and an airgun array. Deep seismic surveys may be either 2D or 3D and are discussed below.

Seismic exploration and development surveys are often conducted over large survey areas (multiple leases and blocks) and obtain information on geological formations to several thousands meters below the ocean floor. For "2D" surveys, a single streamer (hydrophones) is towed behind the survey vessel, together with a single source (airguns) (Gulland and Walker, 1998). Seismic vessels generally operate at low hull speeds (<10 knots) and follow a systematic pattern during a survey, typically a simple grid pattern for 2D work with lines no closer than half a kilometer.

In simplistic terms, "3D" surveys collect a very large number of 2D slices, perhaps with line separations of only 25-30 m (82-98 ft). A 3D survey may take months to complete and involves a precise definition of the survey area and transects, usually a series of passes to cover a given survey area (Caldwell, 2001). In 1984, industry operated the first twin streamers. By 1990, industry achieved a single vessel towing two airgun sources and six streamers. Industry continues to increase the capability of a single vessel, now using eight streamer/dual source configurations and multi-vessel operations (Gulland and Walker, 1998). For exploration surveys, 3D methods represent a substantial improvement in resolution and useful information relative to 2D methods. Many areas in the GOM previously surveyed using 2D have been or will be surveyed using 3D. It can be assumed that for new deepwater areas, 3D surveys would be the preferred method for seismic exploration, until and if better technology evolves.

A typical 3D airgun array would involve 15-30 individual guns. The firing times of the guns are staggered by milliseconds (tuned) in an effort to make the farfield noise pulse as coherent as possible. In short, the intent of a tuned airgun array is to have it emit a very symmetric packet of energy in a very short amount of time, and with a frequency content that penetrates well into the earth at a particular location (Caldwell, 2001). The noise generated by airguns is intermittent, with pulses generally less than one second in duration, for relatively short survey periods of several days to weeks for 2D work and site surveys (Gales, 1982) and weeks to months for 3D surveys (Gulland and Walker, 1998). Airgun arrays produce noise pulses with very high peak levels. The pulses are a fraction of a second and repeat every 5-15 seconds. In other words, while airgun arrays are by far the strongest sources of underwater noise associated with offshore oil and gas activities, because of the short duration of the pulses, the total energy is limited (Gordon and Moscroup, 1996). At distances of about 500 m (1,640 ft) and more (farfield), the array of individual guns would effectively appear to be a single point source (Caldwell, 2001). In the past, sound-energy levels were expected to be less than 200 dB re^{-1}µPa-m (standard unit for source levels of underwater sound: 200 decibels, reference pressure 1 micropascal, reference range 1 meter) at distances beyond 90 m from the source (Gales, 1982). Gulland and Walker (1998) state a typical source would output approximately 220 dB re^{-1}µPa-m, although the peak-to-peak source level directly below a seismic array can be as high as 262 dB re^{-1}µPa-m (Davis et al., 1998b). Recent work by Tolstoy et al. (2004) in the Gulf of Mexico suggests that for deep water (~3200 m) the 180-dB radii would occur at less than 1 km (0.6 mi) from the source, while in shallow waters (~30 m (98 ft)), the 180-dB radii would be considerably larger (e.g., ~3.5 km (2.2 mi)). The 180 dB re^{-1}µPa-m level is an estimate of the threshold of sound energy that may cause hearing damage in cetaceans (U.S. Dept. of the Navy, 2001). Until further studies are completed, NOAA Fisheries Service continues to use this estimated threshold. It is unclear which measurements of a seismic pulse provide the most helpful indications of its potential impact on marine mammals (Gordon et al., 1998). Gordon et al. speculate that peak broadband pressure and pulse time and duration would be most relevant at short ranges (hearing damage range) while sound intensity in 1/3 octave bands is a more useful measurement at distance (behavioral effects).

Information on drilling noise in the GOM is unavailable to date. From studies mostly in Alaskan waters, drilling operations often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are apparently noisier than semisubmersibles (Richardson et al., 1995). Sound and vibration paths to the water are through either the air or the risers, in contrast to the direct paths through the hull of a drillship.

Machinery noise generated during the operation of fixed structures can be continuous or transient, and variable in intensity. Underwater noise from fixed structures ranges from about 20 to 40 dB above background levels within a frequency spectrum of 30-300 hertz (Hz) at a distance of 30 m (98 ft) from the source (Gales, 1982). These levels vary with type of platform and water depth. Underwater noise from platforms standing on metal legs would be expected to be relatively weak because of the small surface area in contact with the water and the placement of machinery on decks well above the water.

Aircraft and vessel support may further ensonify broad areas. Noise generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft while between platforms.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size, laden or not, and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). Given the amount of vessel traffic from all sources in the GOM, CSA concludes that the contribution of noise from offshore service vessels is a minor component of the total ambient noise level (USDOI, MMS, 2004). In the immediate vicinity of a service vessel, noise could disturb marine mammals; however, this effect would be limited in area and duration.

4.1.1.8. Offshore Transport

4.1.1.8.1. Pipelines

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the GOM. Over the last 10 years, the average annual installation rate for OCS pipelines was 1,600 km (994 mi) and more than 250 pipelines and pipeline segments. Pipelines in the CPA accounted for 83 percent of the length installed; pipelines in the WPA accounted for 17 percent. The installation rate for pipelines is expected to remain steady; this includes consideration of expansion and replacement of the existing and aging pipeline infrastructure in the GOM.

Projected Lengths of OCS Pipelines to be Installed during 2007-2046

OCS Program	WPA Proposed Action	CPA Proposed Action
9,470-66,550 km (5,884-41,352 mi)	13-760 km (8-472 mi)	130-1,700 km (81-1,056 mi)

It is expected that pipelines from most of the new offshore production facilities will connect to the existing pipeline infrastructure, which will result in few new pipeline landfalls. Production from a proposed action in the WPA and CPA will contribute 1 percent and 3-4 percent, respectively, to existing and future pipelines and pipeline landfalls. For the period 2007-2046, a range of 32-47 new landfalls is projected for the OCS Program. For each WPA and CPA proposed action, 0-1 new landfalls are projected. See **Chapter 4.1.2.1.7** for a discussion of coastal pipelines.

The typical operational life of a pipeline has been estimated to be 20-40 years, but with current corrosion management, that lifetime has been significantly increased. One technique for extending the operational life of a gas pipeline is to periodically treat the inside of the pipe with a corrosion inhibiting substance (CIS). The treatment may be applied as either an aerosol that is pumped in with the production stream or as a liquid "slug" that is pushed through the pipe with a series of mechanized plungers, referred to as "pigs."

Pipelines constructed in water depths <200 ft (61 m) are potential snags for anchors and trawls, and account for 62 percent of the total pipeline length in Federal waters. According to MMS regulations (30 CFR 250.1003(a)(1)), pipelines with diameters $\geq 8^5/_8$ inches that are installed in water depths <60 m are to be buried to a depth of at least 3 ft below the mudline. The regulations also provide for the burial of any pipeline, regardless of size, if MMS determines that the pipeline may constitute a hazard to other uses of the OCS; in the GOM, MMS has determined that all pipelines installed in water depths <60 m must be buried. The purpose of these requirements is to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. For lines $8^5/_8$ inches and smaller, a waiver of the burial requirement may be requested and may be approved if the line is to be laid in an area where the character of the seafloor will allow the weight of the line to cause it to sink into the sediments (self-burial). For water depths ≤60 m, any length of pipeline that crosses a fairway or anchorage in Federal waters must be buried to a minimum depth of 10 ft below mudline across a fairway and a minimum depth of 16 ft below mudline across an anchorage area. Some operators voluntarily bury these pipelines deeper than the minimum.

Where pipeline burial is necessary, a jetting sled will be used. Such sleds are mounted with high-pressure water jets and pulled along the seafloor behind the pipelaying barge. The water jets are directed downward to dig a trench; the sled guides the pipeline into the trench. Such an apparatus can jet pipe at an average of 1.6 km/day (1.0 mi/day). The cross section of a typical jetted trench for the flowline bundles would be about 4 m^2 (43 ft^2); for deeper burial when crossing a fairway, the cross section would be about 13 m^2. The cross section of a typical jetted trench for the export and interconnecting export pipelines would be about 5 m^2; for a pipeline trench crossing a fairway, the cross section would be about 15 m^2.

Jetting disperses sediments over the otherwise undisturbed water bottom that flanks the jetted trench. The area covered by settled sediment and the thickness of the settled sediment depends upon variations in bottom topography, sediment density, and currents (see also **Chapter 4.1.2.1.7**).

Newer installation methods have allowed the pipeline infrastructure to extend to deeper water. At present, the deepest pipeline in the Gulf is in 2,700 m (8,858 ft) water depth. More than 454 pipelines reach water depths of 400 m (1,312 ft) or more, and 331 of those reach water depths of 800 m (2625 ft) or more.

The following information is from MMS's *Deepwater Gulf of Mexico 2006: America's Expanding Frontier* (USDOI, MMS, 2006d). Gas pipelines account for 62 percent of the total pipeline length approved in deep water since 1990. A large increase in 2001 in oil and gas pipeline miles in deepwater reflects approvals for Canyon Express (Aconcagua, Camden Hills, and King's Peak fields), Horn Mountain, and the Boomvang-Nansen projects. The year 2005 saw the approval of the largest number of miles of pipelines less than or equal to 12 in (30.5 cm) in diameter since the peak year of 2001.

The following information is from MMS's *Deepwater Gulf of Mexico 2006: America's Expanding Frontier* (UDSOI, MMS, 2006d). Pipeline installation activities in deepwater areas can be difficult both in terms of route selection and construction. Depending on the location, the sea-bottom surface can be extremely irregular and present engineering challenges (e.g., high hydrostatic pressure, cold temperatures, and darkness, as well as varying subsurface and bottom current velocities and directions). Rugged seafloor may cause terrain-induced pressures within the pipe that can be operationally problematic, as the oil must be pumped up and down steep slopes. An uneven seafloor could result in unacceptably long lengths of unsupported pipeline, referred to as "spanning," which in turn could lead to pipe failure from bending stress early in the life of the line. It is important to identify areas where significant lengths of pipeline may go unsupported. Accurate, high-resolution geophysical surveying becomes increasingly important in areas with irregular seafloor. Recent advances in surveying techniques have significantly improved the capabilities for accurately defining seafloor conditions, providing the resolution needed to determine areas where pipeline spans may occur. After analyzing survey data, the operator chooses a route that minimizes pipeline length and avoids areas of seafloor geologic structures and obstructions that might cause excessive pipe spanning, unstable seafloor, and potential benthic communities.

The greater pressures and colder temperatures in deep water present difficulties with respect to maintaining the flow of crude oil and gas through pipelines. Under these conditions, the physical and chemical characteristics of the produced hydrocarbons can lead to the accumulation of gas hydrate, paraffin, and other substances within the pipeline. These accumulations can restrict and eventually block flow if not successfully prevented and/or abated. There are physical and chemical techniques that can be applied to manage these potential accumulations. The leading strategy to mitigate these deleterious effects is to minimize heat loss from the system by using insulation. Other measures include forcing plunger-like "pigging" devices through the pipeline to scrape the pipe walls clean, and the continuous injection of flow-assurance chemicals (e.g., methanol or ethylene glycol) into the pipeline system to minimize the formation of flow-inhibiting substances. However, the great water depths of the OCS and the extreme distance to shoreside facilities make these flow-assurance measures difficult to implement and can significantly increase the cost to produce and transport the product. Companies are continuously looking for and developing new technologies such as electrically and water-heated pipelines and burial of pipelines in deepwater for insulation purposes.

Long-distance transport of multiphase well-stream fluids can be achieved with an effectively insulated pipeline. There are several methods to achieve pipeline insulation: pipe-in-pipe systems, which included electrically and water-heated pipelines; pipe with insulating wrap material; and as previously mentioned, buried pipelines where the soils act as an insulator. The design of all of these systems seeks a balance between the high cost of the insulation, the intended operability of the system, and the acceptable risk level. Such systems minimize the costs, revenue loss, and risks from the following:

- hydrate formation during steady state or transient flowing conditions;
- paraffin accumulation on the inner pipe wall that can result in pipeline plugging or flow rate reductions;
- adverse fluid viscosity effects at low temperatures that lead to reduced hydraulic performance or to difficulties restarting a cooled system after a short shut-in; and
- additional surface processing facilities required to heat produced fluids to aid in the separation processes.

Formation of gas hydrates in deepwater operations is a well-recognized and potentially hazardous operational problem in water depths greater than 1,000 ft (300 m). Seabed conditions of high pressure and low temperature become conducive to gas hydrate formation in deepwater. Gas hydrates are ice-like crystalline solids formed by low-molecular-weight hydrocarbon gas molecules (mostly methane) combining with produced water. The formation of gas hydrates is potentially hazardous because hydrates can restrict or even completely block fluid flow in a pipeline, resulting in a possible overpressure condition. The interaction between the water and gas is physical in nature and is not a chemical bond. Gas hydrates are formed and remain stable over a limited range of temperatures and pressures.

Hydrate prevention is normally accomplished through the use of methanol, ethylene glycol, or tri-ethylene glycol as inhibitors, and the use of insulated pipelines and risers. Chemical injection is sometimes provided both at the wellhead and at a location within the well just above the subsurface safety valve. Wells that have the potential for hydrate formation can be treated with either continuous chemical injection or intermittent or "batch" injection. In many cases, batch treatment is sufficient to maintain well flow. In such cases, it is necessary only to inject the inhibitor at well start-up, and the well will continue flowing without the need for further treatment. In the event that a hydrate plug should form in a well that is not being injected with a chemical, the remediation process would be to depressurize the pipelines and inject the chemical. Hydrate formation within a gas sales line can be eliminated by dehydrating the gas with a glycol dehydrating system prior to input of gas into the sales line. In the future, molecular sieve and membrane processes may also be options for dehydrating gas. Monitoring of the dewpoint downstream of the dehydration tower should take place on a continuous basis. In the event that the dehydration equipment is bypassed because it may be temporarily out of service, a chemical could be injected to help prevent the formation of hydrates if the gas purchaser agrees to this arrangement beforehand.

Hydrocarbon flows that contain paraffin or asphaltenes may occlude pipelines as these substances, which have relatively low melting points, form deposits on the interior walls of the pipe. To help ensure product flow under these conditions, an analysis should be made to determine the cloud point and hydrate formation point during normal production temperatures and pressures. To minimize the formation of paraffin or hydrate depositions, wells can be equipped with a chemical injection system. If, despite treatment within the well, it still becomes necessary to inhibit the formation of paraffin in a pipeline, this can be accomplished through the injection of a solvent such as diesel fuel into the pipeline.

Pigging is a term used to describe a mechanical method of displacing a liquid in a pipeline or to clean accumulated paraffin from the interior of the pipeline by using a mechanized plunger or "pig." Paraffin is a waxy substance associated with some types of liquid hydrocarbon production. The physical properties of paraffin are dependent on the composition of the associated crude oil, and temperature and pressure. At atmospheric pressure, paraffin is typically a semisolid at temperatures above about 100 °F and will solidify at about 50 °F. Paraffin deposits will form inside pipelines that transport liquid hydrocarbons and, if some remedial action such as pigging is not taken, the deposited paraffin will eventually completely block all fluid flow through the line. The pigging method involves moving a pipeline pig through the pipeline to be cleaned. Pipeline pigs are available in various shapes and are made of various materials, depending on the pigging task to be accomplished. A pipeline pig can be a disc or a spherical or cylindrical device made of a pliable material such as neoprene rubber and having an outside diameter nearly equal to the inside diameter of the pipeline to be cleaned. The movement of the pig through the pipeline is accomplished by applying pressure from gas or a liquid such as oil or water to the back or upstream end of the pig. The pig fits inside the pipe closely enough to form a seal against the applied pressure. The applied pressure then causes the pig to move forward through the pipe. As the pig travels through the pipe, it scrapes the inside of the pipe and sweeps any accumulated contaminants or liquids ahead of it. In deepwater operations, pigging will be used to remove any paraffin deposition in the pipelines as a normal part of production operations. Routine pigging will be required of oil sale lines at frequencies determined by production rates and operating temperatures. The frequency of pigging could range from several times a week to monthly or longer, depending on the nature of the produced fluid. In cases where paraffin accumulation cannot be mitigated, extreme measures can be taken in some cases such as coil tubing entry into a pipeline to allow washing (dissolving) of paraffin plugs. If that fails, then it could result in having to replace a pipeline.

Pipeline Applications

Review of pipeline applications includes the evaluation of protective safety devices such as pressure sensors and automatic valves, and the physical arrangement of those devices proposed to be installed by the applicant. The purpose of the safety devices is to protect the pipeline from possible overpressure conditions and for detecting and initiating a response to abnormally low-pressure conditions. Once a pipeline is installed, operators conduct monthly overflights to inspect pipeline routes for leakage. **Chapter 1.5**, Postlease Activities (Pollution Prevention), discusses this topic in depth.

Applications for pipeline decommissioning must also be submitted for MMS review and approval. Decommissioning applications are evaluated to ensure they will render the pipeline inert, to minimize the potential for the pipeline becoming a source of pollution by flushing and plugging the ends, and to minimize the likelihood that the decommissioned line will become an obstruction to other users of the OCS by filling it with water and burying the ends.

High Integrity Pressure Protection System (HIPPS)

The following information is from MMS's *Deepwater Gulf of Mexico 2006: America's Expanding Frontier* (USDOI, MMS, 2006d).

The longer subsea tiebacks being used to develop marginal deepwater fields pose another challenge for industry, namely in the design and installation of pipelines rated for the HPHT well's shut-in tubing pressure (SITP) of 15,000 pounds per square inch (psi) and/or 350 °F (177 °C). Rather than relying on the physical strength of steel to withstand the SITP, a high-integrity pressure protection system (HIPPS) provides alternate overpressure protection for a pipeline or flowline. The HIPPS employs valves, logic controllers, and pressure transmitters to shut down the system before a pipeline is overpressured and/or ruptured.

The MMS has been working with API and DeepStar to formulate the regulatory framework for the installation of an HIPPS in the GOM. DeepStar is a joint industry technology development project representing large and mid-size operators to help address common deepwater business challenges. DeepStar is expected to finish its HIPPS study in 2006, and API will address HIPPS in its Recommended Practice API RP 17 O in late 2006 or early 2007. However, it is anticipated that the GOM Region will receive applications for the use of an HIPPS in 2006. Once design specifications for each section of the HIPPS system are finalized, MMS will hold operators to the design codes.

Proposed Action Scenario: There are 130-760 km (8-472 mi) of new pipelines projected as a result of a WPA proposed action (**Table 4-2**) and 130-1,700 km (81-1,056 mi) as a result of a CPA proposed action (**Table 4-3**). For WPA and CPA proposed actions, about half of the new pipeline length would be in water depths <60 m (197 ft) requiring burial. There are 0-1 new landfalls for a WPA proposed action and 0-1 for a CPA proposed action.

The length of new pipelines was estimated using the amount of production, the number of structures projected as a result of the proposed actions, and the location of the existing pipelines. The range in length of pipelines projected is because of the uncertainty of the location of new structures and which existing or proposed pipelines would be utilized. Many factors would affect the actual transport system, including company affiliations, amount of production, product type, and system capacity.

OCS Program Scenario: From 2007 to 2046, 9,470-66,550 km (5,884-41,352 mi) of new pipeline are projected as a result of the OCS Program (**Table 4-4**). About half of the new pipeline length would be in water depths <60 m (197 ft), requiring burial.

4.1.1.8.2. Barges

It is assumed that barging will continue to account for less than 1 percent of the oil transported for the entire OCS Program and the WPA and CPA proposed actions. **Tables 4-2 and 4-3** provide the percentages of oil barged to shore by subarea for the proposed actions and the OCS Program. **Tables 4-4, 4-5, and 4-6** provide the percentages of oil barged to shore for the OCS Program by planning area.

The capacity of oil barges used offshore can range from 5,000 to 80,000 bbl. Barges transporting oil may remain offshore for as long as one week while collecting oil; each round trip is assumed to be five days. Assuming that about eight barge systems will continue operating in the GOM and that the barge will go out once a month to pick up oil from the platforms in each system, nearly 100 trips are projected to occur annually in the GOM. Only primary barging activity from offshore production platforms to onshore terminals is considered in these projections. It is assumed that the WPA proposed action will account for 1 percent of the volume barged by these trips over a 35-year production period. The CPA proposed action will account for 3-4 percent of the volume barged by these trips over a 35-year production period.

4.1.1.8.3. Oil Tankers

Shuttle tanker transport of GOM OCS-produced oil has not occurred to date. Tankering is projected for some future OCS operations located in deepwater beyond the existing pipeline network. In early 1997, discussions between industry and MMS began concerning the feasibility of floating production, storage, and offloading (FPSO) systems and associated tanker transport of OCS-produced oil in the GOM. The FPSO's are floating production systems that store crude oil in tanks located in the hull of the vessel and periodically offload the crude to shuttle tankers or ocean-going barges for transport to shore. The FPSO's may be used to develop marginal oil fields or used in areas remote from the existing OCS pipeline infrastructure. A workshop was held in April 1997 to identify significant issues related to four areas: environmental effects, conservation of oil and gas resources, technology, and regulatory framework. Subsequent to the workshop, MMS prepared an EIS to evaluate potential environmental effects of the proposed use of FPSO systems and tankering in the deepwater CPA and WPA. The MMS funded a comparative risk analysis that looked at risks associated with FPSO's and tankering in relation to risks associated with three currently accepted deepwater production systems and oil pipelines. A joint MMS/USCG/industry team has reviewed the existing MMS and USCG regulatory framework applicable to FPSO's and shuttle tankering.

Shuttle tankers would be used to transport crude oil from FPSO production systems to Gulf Coast refinery ports or to offshore deepwater ports such as the Louisiana Offshore Oil Port (LOOP). The shuttle tanker design and systems would be in compliance with USCG regulations. Under the Jones Act and OPA 90 requirements, shuttle tankers would be required to be double hulled. Shuttles can have internal propulsion systems, or they may use other propulsion system configurations, such as an articulated tug barge (ATB). The ATB's involve the connectable/disconnectable integration of a tug-type vessel to a recess in the stern of a large-capacity barge. Shuttle tankers also vary in size. In the Gulf, the maximum size of shuttle tankers is limited primarily by the 34- to 47-ft water depths of U.S. Gulf Coast refinery ports. Because of these depth limitations, shuttle tankers are likely to be 500,000-550,000 bbl in cargo capacity.

Offloading operations involve the arrival, positioning, and hook-up of a shuttle tanker to the FPSO. Shuttle tankers could maintain their station during FPSO offloading operations using several techniques. These include side-by-side mooring to the FPSO, use of a hawser mooring system with or without thruster assist, or by use of a dynamic positioning system that maintains the vessel's station by use of thrusters rather than mooring lines. Hawser mooring systems used in a tandem offloading configuration is the most likely configuration for FPSO offloading operations in the GOM. Offloading would occur at an average rate 50,000 barrels per hour (BPH). During the FPSO offloading procedure, the shuttle tanker would continue to operate its engines in an idle mode so that any necessary maneuvers of the vessel could be promptly executed.

Tandem offloading would occur under maximum wave height limitations of 3.5 m (11.5 ft) for hook up/connection and 4.5 m (14.8 ft) for disconnect. These wave height limitations are currently being used in the North Sea. Hook-up is accomplished by the use of a retractable hose and a messenger line that is fired from the FPSO to the shuttle tanker via compressed air. The hawser and hose(s) are then pulled over to the shuttle tanker and connected. Cargo oil would be offloaded to the shuttle tanker using the FPSO's main cargo pumps, with oil being routed through a deck line to a stern offloading station, and then through a floating hose to the midship loading manifold of the tanker. Safety features, such as marine break-away offloading hoses and emergency shut-off valves, will be incorporated in order to minimize the potential for, and size of, an oil spill. In addition, weather and sea-state limitations will be established to further ensure that hook-up and disconnect operations will not lead to accidental oil release. A vapor recovery system between the FPSO and shuttle tanker will be employed to minimize release of fugitive emissions from cargo tanks during offloading operations.

To develop a scenario for analytical purposes, the following assumptions are made regarding future OCS oil transportation by shuttle tanker:

- advances in pipelaying technology will keep pace with the expansion of the oil industry into the deeper waters of the Gulf beyond the continental slope;
- all produced gas will be piped;
- tankering will not occur from operations on the continental shelf;
- tankering will only take place from marginal fields or fields in areas remote from the existing OCS pipeline infrastructure; and
- offloading frequency for an FPSO would be once every three days during peak production.

The number of shuttle tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000-bbl capacity, offloading would occur once every 3.3 days. This would equate to a 54.75-MMbbl production with 110 offloading events and shuttle tanker transits to Gulf coastal or offshore ports annually per FPSO.

WPA Proposed Action Scenario: As a result of the WPA proposed action, the use of FPSO's is projected in water depths greater than 800 m (2,625 ft). Up to 330 offloading operations and shuttle tanker transits will occur annually during the peak years of FPSO use.

CPA Proposed Action Scenario: As a result of the CPA proposed action, the use of FPSO's is projected in water depths greater than 800 m (2,625 ft). Up to 330 offloading operations and shuttle tanker transits will occur annually during the peak years of FPSO use. The majority of operations and transits would occur at the lower Mississippi River ports and the Louisiana Offshore Oil Port, Louisiana.

OCS Program Scenario: As a result of the OCS Program, the use of FPSO is projected in water depths greater than 800 m (2,625 ft) in the WPA and CPA. Up to 1,210 offloading operations and shuttle tanker transits will occur annually during the peak years of FPSO use.

4.1.1.8.4. Service Vessels

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. A trip is considered the transportation from a service base to an offshore site and back, in other words a round trip. Based on MMS calculations, each vessel makes an average of eight round trips per week for 42 days in support of drilling an exploration well and six round trips per week for 45 days in support of drilling an a development well. A platform in shallow water (<400 m (1,312 ft)) is estimated to require one vessel trip every 10 days over its 25-year production life. A platform in deep water (>400 m, 1,312 ft) is estimated to require one vessel trip every 1.75 days over its 25-year production life. All trips are assumed to originate from the service base.

Proposed Action Scenario: Service-vessel trips projected for a proposed action in the WPA are 94,000-155,000 trips (**Table 4-2**). This equates to an average annual rate of 2,350-3,875 trips. A proposed action in the CPA is estimated to generate 117,000-239,000 service-vessel trips or 2,925-5,975 trips annually (**Table 4-3**).

OCS Program Scenario: The projected number of service-vessel trips estimated for the OCS Program is 6,714,000-8,608,000 over the 2007-2046 period (**Table 4-4**). This equates to an average rate of 167,850-215,200 trips annually.

4.1.1.8.5. Helicopters

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. An operation is considered a take off and landing.

Deepwater operations require helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating costs. There are several issues of concern for the helicopter industry's future. Since the tasks the offshore helicopter industry provides are the same tasks supply vessels provide, they are competition for one another. Fast boats are beginning to erode the helicopter industry's share of the offshore transportation business, particularly in shallow water. The exploration and production industry is outsourcing more and more operations to oil-field support companies who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

To meet the demands of deepwater activities, the offshore helicopter industry is purchasing new helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating cost. Also, instead of running their own fleets, oil and gas companies are increasingly subcontracting all helicopter support to independent contractors who are very cost conscience. The number of helicopters operating in the GOM is expected to decrease in the future, and helicopters that do operate are expected to be larger and faster.

According to the Helicopter Safety Advisory Conference (2006), from 1996 to 2003, helicopter operations (take offs and landings) in support of Gulfwide OCS operations have averaged, annually, 1.5 million operations, 3.1 million passengers, and 430,000 flight hours. The proposed action and OCS Program scenarios below use the current level of activity as a basis for projecting future helicopter operations.

Proposed Action Scenario: Helicopter operations projected for a proposed action in the WPA are 400,000-900,000 operations (**Table 4-2**). This equates to an average annual rate of 10,000-22,500 operations. A proposed action in the CPA is projected to generate 1,000,000-2,200,000 helicopter operations or 25,000-55,000 operations annually (**Table 4-3**).

OCS Program Scenario: The projected number of helicopter operations for the OCS Program is 38,000,000-60,000,000 operations over the 2007-2046 period (**Table 4-4**). This equates to an average rate of 950,000-1,500,000 operations annually.

4.1.1.8.6. Alternative Transportation Methods of Natural Gas

Trends in energy supply and demand are affected by a large number of factors that are difficult to predict, such as energy prices, U.S. economic growth, advances in technologies, changes in weather patterns, and future public policy decisions. According to the Federal Energy Regulatory Commission (FERC), natural gas accounts for almost one-fourth of all energy consumed in the U.S. The U.S. Energy Information Administration (EIA) forecasts natural gas demand to grow to almost 40 percent by 2025 (FERC, 2004). As the country's gas consumption is expected to increase significantly over the next 20 years, industry is looking at alternative methods of transporting OCS gas in the GOM.

These alternative methods involve transporting natural gas as liquefied natural gas (LNG) or compressed natural gas (CNG) in specially designed vessels. The focus has been on deep water where it is costly and technically challenging to install pipelines to transport associated gas. The LNG and CNG options may make it economically viable to produce marginal gas fields. The CNG option may also be an economical way of transporting "stranded" associated gas instead of the gas being flared or re-injected. Although both technologies could bring gas to shore, most discussions suggest the use of offshore terminals and the existing nearshore pipeline infrastructure. The offloading gas terminals would require USCG-designated safety zones with "no surface occupancy" restrictions for oil and gas exploration, development, and production operations.

The LNG is a clear liquid that is odorless, colorless, noncorrosive, and nontoxic. The physical properties of LNG allow for its long-distance transport by ship across oceans and for its local distribution by truck onshore. In the LNG process, gas is super-cooled, reducing its volume to a fraction of its gaseous state. The LNG is stored in double-walled, insulated tanks that are designed to minimize any gas from escaping. Pressure in these tanks is very low (about 1 atmosphere). There is also a dike or impounding wall around the tank that is capable of containing the entire volume of the tank, in the event of a spill. This would prevent any LNG from flowing off the site. Then, tankers transport the LNG to terminals for re-gasification.

At present, LNG is being imported into five existing U.S. terminals, and more terminals are proposed. The four existing onshore facilities are located in Everett, Massachusetts; Cove Point, Maryland; Elba Island, Georgia; and Lake Charles, Louisiana. The Lake Charles Terminal is located 48 mi from the GOM and is the largest LNG import terminal in the U.S. Following the completion of its planned expansion, which includes an additional 3 Bcf of storage, it will remain the largest. The expansion also includes an increase in peak sendout capacity from 1.0 Bcf per day to 1.3 Bcf per day. The Lake Charles facility was completed in 1982 but operated only a short time before closing; it reopened in 1989 and has been in operation since that time as an import terminal (USDOE, EIA, 2003). The fifth operational terminal is the Gulf Gateway Energy Bridge, located in the offshore GOM. It is the first new U.S. LNG terminal to be constructed in more than 20 years, and it received its first cargo in March 2005 (USDOE, EIA, 2005h).

The CNG, like LNG, is odorless, colorless, and tasteless and consists mostly of methane. The CNG process uses less energy than the LNG process because liquefaction and regasification are not required as it is with LNG. The CNG does not have the cryogenic issues associated with LNG projects. However, CNG is stored at a much higher pressure than LNG. The CNG technology provides an effective way for shorter-distance transport of the gas. The CNG technology is easy to deploy with less requirements for facilities and infrastructure. Additionally, CNG may be refueled from low-pressure or high-pressure systems. The difference lies in the cost of the station versus the refueling time.

4.1.1.9. Hydrogen Sulfide and Sulfurous Petroleum

Sulfur may be present in oil as elemental sulfur, within hydrogen sulfide (H_2S) gas, or within organic molecules, all three of which vary in concentration independently. Although sulfur-rich petroleum is often called "sour" regardless of the type of sulfur present, the term "sour" should properly be applied to petroleum containing appreciable amounts of H_2S, and “sulfurous” should be applied to other sulfur-rich petroleum types. Using this terminology, the following matrix of concerns is recognized:

Potentially Affected Endpoint	Sour Natural Gas	Sour Oil	Sulfurous Oil
Engineering	Equipment and pipeline corrosion	Equipment and pipeline corrosion	N/A
On-Platform Industrial Hygiene	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Off-Platform General Human Health and Safety	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Marine and Coastal Species and Habitats	Irritation, injury, and lethality from leaks	Synergistic amplification of oil-spill impacts from outgassing	No effects other than impacts hydrocarbon contact and acid rain

Sour Oil, Sour Gas, and Sulfurous Oil in the Gulf of Mexico

Occurrence

Sour oil and gas occur sporadically throughout the GOM OCS, primarily off the Louisiana, Mississippi, and Alabama coasts. Occurrences of H_2S offshore Texas are in Miocene rocks and occur principally within a geographically narrow band. The occurrences of H_2S offshore Louisiana are mostly associated with salt and gypsum deposits. Examination of industry exploration and production data show H_2S concentrations vary from fractional ppm, in either oil or gas, to 650,000 ppm in the gas phase of a single oil well. The next highest concentrations of H_2S have been in the range of 20,000-55,000 ppm in some natural gas wells offshore Mississippi/Alabama. There is some evidence that petroleum from deepwater areas may be sulfurous, but there is no evidence that it is sour. Deep gas reservoirs on the GOM continental shelf are likely to have high corrosive content, including H_2S.

Treatment (Sweetening)

Removal of H_2S from sour petroleum may proceed in one of two ways. The product can either be “sweetened” (removal of H_2S from the hydrocarbons) offshore or it can be transported onshore to a processing facility equipped to handle H_2S hydrocarbons, where the product is sweetened. Several processes, based on a variety of chemical and physical principles, have been developed for gas sweetening. The processes include solid bed absorption, chemical solvents (e.g., amine units), physical solvents, direct conversion of H_2S to sulfur (e.g., Claus units), distillation, and gas permeation (Arnold and Stewart, 1988). Gas streams with H_2S or SO_2 are frequently treated offshore by amine units to reduce the corrosive properties of the product. A by-product of this process is a concentrated acid gas stream, which is frequently treated as a waste and flared if SO_2 emissions are not of concern. In cases where SO_2 emissions must be minimized, other options for handling acid gas must be sought. Sulfur recovery units to further process the H_2S to elemental sulfur or reduced sulfur compounds is a common method of treating acid gas streams. Re-injection of acid gas is an option that has also been considered. The feasibility of re-injecting acid gas in the offshore environment has not been demonstrated. In addition, MMS conservation requirements may not allow re-injection of this gas. Another option would be to send the untreated gas to shore for treatment; this requires the use of “sour gas” pipelines built to handle the highly corrosive materials.

Requirements for Safety Planning and Engineering Standards

The MMS reviews all proposed actions in the GOM OCS for the possible presence of H_2S. Activities found to be associated with a presence of H_2S are subjected to further review and requirements. Federal regulations at 30 CFR 250 require all lessees, prior to beginning exploration or development operations, to request a classification of the potential for encountering H_2S. The classification is based on previous drilling and production experience in the areas surrounding the proposed operations, as well as other factors. All operators on the OCS involved in production of sour gas or oil (i.e., greater than 20 ppm H_2S) are also required to file an H_2S contingency plan. This plan delimits procedures to ensure the safety of the workers on the production facility. In addition, all operators are required to adhere to the National Association of Corrosion Engineers' (NACE) *Standard Material Requirement MR.01-75-96 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment* (NACE, 1990). These engineering standards serve to enhance the integrity of the infrastructure used to produce the sour oil and gas, and further serve to ensure safe operations. The MMS has issued a final rule governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulfur dioxide, protecting personnel, providing warning systems, and establishing requirements for hydrogen sulfide flaring. The rule went into effect on March 28, 1997. An associated NTL (98-16) titled "Hydrogen Sulfide (H_2S) Requirements" was issued on August 10, 1998, to provide clarification, guidance, and information on the revised requirements. The NTL provides guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

Environmental Fate of H_2S

Atmospheric Release

Normally, dispersion mechanisms in the surface mixed layer of the atmosphere (wind, etc.) cause natural gas leaks and associated H_2S to disperse away from release sites. The MMS reviews of proposed sour gas operations are based on the conservative assumptions of horizontal, non-combusted releases to achieve environmentally conservative results, although vertical release or combustion of the gas plume (greatly reducing potential exposure) would be possible. Both simple Gaussian estimation techniques (conforming to air quality rules) and more rigorous analytical modeling are used in the MMS review of activities associated with a presence of H_2S. For a very large facility (throughput on the order of 100 MMcfd of produced natural gas) with high concentration levels (on the order of 20,000 ppm) and using very calm winds (speed of <1 m/sec), H_2S levels reduce to 20 ppm at several kilometers from the source; H_2S levels are reduced to 500 ppm at 1 km (0.6 mi). Most "sour gas" facilities have H_2S concentrations below 500 ppm, which reduces to 20 ppm within the dimensions of a typical platform (or considerably less).

Aquatic Release

Hydrogen sulfide is soluble in water with 4,000 ppm dissolving in water at 20°C and one atmosphere pressure. This implies that a small sour gas leak would result in almost complete dissolution of the contained H_2S into the water column. Larger leaks would result in proportionally less dissolution, depending on turbulence, depth of release, and temperature; and H_2S could be released into the atmosphere if the surrounding waters reach saturation or the gas plume reaches the surface before complete dissolution. Because the oxidation of H_2S in the water column takes place slowly (on the order of hours), the chemical oxygen demand of H_2S is spread out over a long time interval (related to the ambient current speed) and should not create appreciable zones of hypoxia; except, in the case of a very large, long-lived submarine release.

H_2S Toxicology

Humans

The Occupational Safety and Health Administration's permissible exposure limit for H_2S is 20 ppm. A permissible exposure limit is an allowable exposure level in workplace air averaged over an 8-hour period. The American Conference of Governmental Hygienists recommends a time weighted average concentration of 10 ppm. The time-weighted average is a concentration for a normal 8-hour workday to which nearly all workers may be repeatedly exposed, day after day, without adverse affect. This is 30 times lower than the "immediately dangerous to life and health" level of 100 ppm set by the National Institute for Occupational Safety and Health. Despite a normal human ability to smell H_2S at levels below 1 ppm, H_2S is considered to be an insidious poison because the sense of smell rapidly fatigues, failing to detect H_2S after continued exposure. Although there are many different systems of classifying exposure levels and their associated health risks, MMS has synthesized these into a single, simple set of concentration levels to be used in identifying and assessing exposure risks:

Atmospheric Exposure Levels (volume fractions)	Characteristic Human Health Impact	Protective Measures Taken by MMS at this Level
20 ppm	Irritation within minutes	Operator required to develop and file "H_2S Contingency Plan"
100 ppm	Injury within minutes	
500 ppm	Death within minutes	Operator required to model atmospheric dispersion of total, horizontal, noncombusted rupture

Wildlife

While impacts on humans are well documented, the literature on the impact of H_2S on wildlife is sparse, with no information available for marine mammals and turtles.

In general, birds seem more tolerant of H_2S than mammals, indicating that birds may have a higher blood capacity to oxidize H_2S to nontoxic forms. In tests with white leghorn chickens, all birds died when inhaling H_2S at 4,000 ppm. At 500 ppm, no impact was observed on ventilation, while between 2,000 and 3,000 ppm respiratory frequency and tidal volume become irregular and variable in these birds (Klentz and Fedde, 1978). In the western United States, oil production and geothermal operations often flare or vent pipes to release the natural gases accumulated during drilling, storage, and pipeline operations, with significant impacts on wildlife (Maniero, 1996). Numerous instances of dead birds at the release site have been reported in the literature; extremely high concentrations of H_2S would occur at these sites.

Fish

Toxicity data presented below has been centered around the effects on predominantly freshwater organisms. Toxicity effects offshore and in the coastal waters may differ significantly.

Fish will strongly avoid any water column that is contaminated with H_2S, provided an escape route is available. In terms of acute toxicity testing, fish can survive at levels reaching 0.4 ppm (Van Horn, 1958; Theede et al., 1969). Walleye eggs (*Stizostedion vitreum*) did not hatch at levels from 0.02 to 0.1 ppm (USEPA, 1986). The hatchability of northern pike (*Esox lucius*) was substantially reduced at 25 parts per billion (ppb) with complete mortality at 45 ppb. Northern pike fry had 96-hour LC_{50} values that varied from 17 to 32 ppb at O_2 levels of 6 ppm. Sensitive eggs and fry of northern pike exhibited no observable effects at 14 and 4 ppb, respectively (Adelman and Smith, 1970; USEPA, 1986). In a series of tests on the eggs, fry, and juveniles of walleyes, white suckers (*Catostomus commersoni*), and fathead minnows (*Pimephales promelas*), with various levels of H_2S from 2.9 to 12 ppb, eggs were the least sensitive while juveniles were the most sensitive. In 96-hour bioassays, fathead minnows and goldfish (*Carassius auratus)* varied greatly in tolerance to H_2S with changes in temperature (Smith et al., 1976; USEPA, 1986). Pacific salmon (*Oncorhynchus sp.*) experienced 100 percent mortality within 72 hours at 1 ppm.

On the basis of chronic toxicity testing, juveniles and adults of bluegill (*Lepomis macrochirus*) exposed to 2 ppb survived and grew normally. Egg deposition in bluegills was reduced after 46 days of exposure to 1.4 ppb (Smith et al., 1976; USEPA, 1986). White sucker eggs were hatched at 15 ppb, but juveniles showed growth reductions at 1 ppb. Safe levels for fathead minnows were between 2 and 3 ppb. For *Gammarus pseudolimnaeus* and *Hexagenia limbata*, 2 and 15 ppb, respectively, were considered safe levels (USEPA, 1986).

4.1.1.10. New and Unusual Technologies

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. The MMS prepared a programmatic EA to evaluate potential effects of deepwater technologies and operations (USDOI, MMS, 2000). As a supplement to the EA, MMS prepared a series of technical papers that provides a profile of the different types of development and production structures that may be employed in the GOM deepwater (Regg et al., 2000). The EA and technical papers were used in the preparation of this EIS.

The operator must identify new or unusual technology (NUT) in exploration and development plans. Some of the technologies proposed for use by the operators are actually extended applications of existing technologies and interface with the environment in essentially the same way as well-known or conventional technologies. These technologies are reviewed by MMS for alternative compliance or departures that may trigger additional environmental review. Some examples of new technologies that do not affect the environment differently and that are being deployed in the Gulfwide OCS Program are synthetic mooring lines, subsurface safety devices, and multiplex subsea controls.

Some new technologies differ in how they function or interface with the environment. These include equipment or procedures that have not been installed or used in GOM OCS waters. Having no operational history, they have not been assessed by MMS through technical and environmental reviews. New technologies may be outside the framework established by MMS regulations and, thus, their performance (safety, environmental protection, efficiency, etc.) has not been studied by MMS. The degree to which these new technologies interface with the environment and the potential impacts that may result are considered in determining the level of NEPA review that would be initiated if an operator wishes to deploy it.

The MMS has developed a NUT's matrix to help facilitate decisions on the appropriate level of engineering and environmental review needed for a proposed technology. Technologies will be added to the NUT's matrix as they emerge, and technologies will be removed as sufficient experience is gained in their implementation. From an environmental perspective, the matrix characterizes new technologies into three components: technologies that may affect the environment; technologies that do not interact with the environment any differently than "conventional" technologies; and technologies for which MMS does not have sufficient information to determine its potential impacts to the environment. In this later case, MMS will seek to gain the necessary information from operators or manufacturers regarding the technologies to make an appropriate determination on its potential effects on the environment.

Alternative Compliance and Departures: The MMS's project-specific engineering safety review ensures that equipment proposed for use is designed to withstand the operational and environmental condition in which it would operate. When an OCS operator proposes the use of technology or procedures not specifically addressed in established MMS regulations, the operations are evaluated for alternative compliance or departure determination. Any new technologies or equipment that represent an alternative compliance or departure from existing MMS regulation must be fully described and justified before it would be approved for use. For MMS to grant alternative compliance or departure approval, the operator must demonstrate an equivalent or improved degree of protection as specified in 30 CFR 250.141. Comparative analysis with other approved systems, equipment, and procedures is one tool that MMS uses to assess the adequacy of protection provided by alternative technology or operations. Actual operational experience is necessary with alternative compliance measures before MMS would consider them as proven technology.

4.1.1.11. Decommissioning and Removal Operations

During exploration, development, and production operations, the seafloor around activity sites within the proposed lease sale area becomes the repository of temporary and permanent equipment and structures. In compliance with Section 22 of MMS's Oil and Gas Lease Form (MMS-2005) and OCSLA regulations (30 CFR §250.1710 — wellheads/casings and 30 CFR §250.1725 — platforms and other facilities), lessees are required to remove all seafloor obstructions from their leases within one year of lease termination or relinquishment. These regulations require lessees to sever bottom-founded structures and their related components at least 5 m (15 ft) below the mudline to ensure that nothing would be exposed that could interfere with future lessees and other activities in the area. The structures are generally grouped into two main categories depending upon their relationship to the platform/facilities (piles, jackets, caissons, templates, mooring devises, etc.) or the well (i.e., wellheads, casings, casing stubs, etc.).

There are possible exemptions to the one-year deadline, including the exemptions stated in Section 388 of the Energy Policy Act. Section 388 clarifies the Secretary's authority to allow an offshore oil and gas structure, previously permitted under the OCSLA, to remain in place after oil and gas activities have ceased in order to allow the use of the structure for other energy and marine-related activities. This authority provides opportunities to extend the life of facilities for non-oil and gas purposes, such as research, renewable energy production, aquaculture, etc., before being removed.

A varied assortment of severing devices and methodologies has been designed to cut structural targets during the course of decommissioning activities. These devices are generally grouped and classified as either nonexplosive or explosive, and they can be deployed and operated by divers, remotely-operated vehicles (ROV's), or from the surface. Which severing tool the operators and contractors use takes into consideration the target size and type, water depth, economics, environmental concerns, tool availability, and weather conditions.

Nonexplosive severing tools are used on the OCS for a wide array of structure and well decommissioning targets in all water depths. Based on 10 years of historical data (1994-2003), nonexplosive severing is employed exclusively on about 58 (~37%) removals per year (USDOI, MMS, 2005a). Since many decommissionings use both explosive and nonexplosive technologies (prearranged or as a backup method), the number of instances may be much greater. Over the next 5 years, MMS estimates that 55-94 structure removals could employ nonexplosive severance annually. Common nonexplosive severing tools consist of abrasive cutters (e.g., sand cutters and abrasive water jets), mechanical (carbide) cutters, diver cutting (e.g., underwater arc cutters and the oxyacetylene/oxy-hydrogen torches), and diamond wire cutters.

With the exception of minor air and water quality concerns (i.e., exhaust from support equipment and toxicity of abrasive materials), nonexplosive severing tools generally cause little to no environmental impacts; therefore, there are very few regulations regarding their use. However, the use of nonexplosive cutters leads to greater human health and safety concerns, primarily because (1) divers are often required in the methodology (e.g., torch/underwater arc cutting and external tool installation and monitoring), (2) more personnel are required to operate them (increasing their risks of injury in the offshore environment), (3) lower success rates require that additional cutting attempts be made, and (4) the cutters can only sever one target at a time; taking on average 30 minutes to several hours for a complete cut (USDOI, MMS, 2005a). The last two items are often hard to quantify and assign risks to the cutters, but the main principle is that there is a linear relationship between the length of time any offshore operation is staged and on-site (exposure time) and the potential for an accident to occur (TSB and CES, LSU, 2004). Therefore, even if there are no direct injuries or incidents involving a diver or severing technicians, the increased "exposure time" needed to successfully sever all necessary targets could result in unrelated accidents involving other barge/vessel personnel.

Explosive severance tools can be deployed on almost all structural and well targets in all water depths. Historically, explosive charges are used in about 98 (~63%) decommissioning operations annually (USDOI, MMS, 2005a), often as a back-up cutter when other methodologies prove unsuccessful. Explosives work to sever their targets by using (1) mechanical distortion (ripping), (2) high-velocity jet cutting, and (3) fracturing or "spalling."

Mechanical distortion is best exhibited with the use of explosives such as standard and configured bulk charges. If the situation calls for minimal distortion and an extremely clean severing, most contractors rely upon the jet-cutting capabilities of shaped charges. In order to "cut" with these explosives, the specialized charges are designed to use the high-velocity forces released at detonation to transform a metal liner (often copper) into a thin jet that slices through its target. The least used method of severing currently in use on the GOM OCS is fracturing, which uses a specialized charge to focus pressure waves into the target wall and use refraction forces to spall or fracture the steel on the opposing side (NRC, 1996).

The MMS first addressed removal operations and the potential impacts of severing methodologies (nonexplosive/explosive tools) in a programmatic EA (PEA) prepared in 1987 (USDOI, MMS, 1987). The scope of the decommissioning activities analyzed in the document was limited to traditional, bottom-founded structures (i.e., well protectors, caissons, and jacketed platforms) and did not address well abandonment operations; activities similar in nature, but monitored and reported according to a separate section of the OCSLA regulations. In addition, since the majority of removal operations took place in water depths less than 200 m (656 ft), only the shelf areas of the CPA/WPA were addressed by the proposed action.

In 1988, MMS requested a "generic" consultation from the NOAA Fisheries Service of the National Oceanographic and Atmospheric Administration (NOAA) pursuant to Section 7 of the Endangered Species Act (ESA) concerning potential impacts on endangered and threatened species associated with explosive-severance activities conducted during structure-removal operations. Much like the PEA, the consultation's "generic" Biological Opinion (BiO) was limited to the best scientific information available and concentrated primarily on the majority of structure removals (water depths <200 m (656 ft)). The Incidental Take Statement (ITS) was therefore limited to the five species of sea turtle found on the shallow shelf. Reporting guidelines and specific mitigation measures are outlined in the ITS and include (1) the use of a qualified NOAA Fisheries Service observer, (2) aerial surveys, (3) detonation delay radii, (4) nighttime blast restrictions, (5) charge staggering and grouping, and (6) possible diver survey requirements.

Emphasizing a continued need for an incentive to keep explosive weights low, MMS formally requested that NOAA Fisheries Service amend the 1988 BiO to establish a minimum charge size of 5 lb. NOAA Fisheries Service Southeast Regional Office (SERO) subsequently addressed explosive charges ≤5 lb in a separate, informal BiO. The October 2003 "de-minimus" BiO waives several mitigative measures of the "generic" 1988 BiO (i.e., aerial observations, 48-hr predetonation observer coverage, onsite NOAA personnel, etc.), reduces the potential impact zone from 3,000 ft to 700 ft and gives the operators/severing contractors the opportunity to conduct their own observation work.

In 1989, API petitioned NOAA Fisheries Service under Subpart A of the Marine Mammal Protection Act (MMPA) regulations for the incidental take of spotted and bottlenose dolphins during structure-removal operations (i.e., for either explosive- or nonexplosive-severance activities). The Incidental Take Authorization regulations were promulgated by NOAA Fisheries Service in October 1995 (60 FR 53139, October 12, 1995), and on April 10, 1996 (61 FR 15884), the regulations were moved to Subpart M (50 CFR 216.141 et seq.). Effective for five years, the regulations detailed conditions, reporting requirements, and mitigative measures similar to those listed in the 1988 ESA Consultation requirements for sea turtles. After the regulations expired in November 2000, NOAA Fisheries Service and MMS advised operators to continue following the guidelines and mitigative measures of the lapsed subpart pending a new petition and subsequent regulations. At industry's prompting, NOAA Fisheries Service released Interim regulations in August 2002, which expired on February 2, 2004. Operators have continued to follow the Interim conditions until NOAA Fisheries Service promulgates new regulations.

The MMS recently prepared a new PEA, *Structure-Removal Operations on the GOM Outer Continental Shelf* (USDOI, MMS, 2005a), to evaluate the full range of potential environmental impacts of structure-removal activities in all water depths in the CPA and WPA and the Sale 181/189 area in the EPA of the GOM. The activities analyzed in the PEA include vessel and equipment mobilization, structure preparation, nonexplosive- and explosive-severance activities, post-severance lifting and salvage, and site-clearance verification. The impact-producing factors of structure removals considered in the PEA include seafloor disturbances, air emissions and water discharges, pressure and acoustic energy from explosive detonations, and space-use conflicts with other OCS users. No potentially significant impacts were identified for air and water quality; marine mammals and sea turtles; fish, benthic, and archaeological resources; or other OCS pipeline, navigation, and military uses. On the basis of this PEA, MMS determined that an EIS was not required and prepared a Finding of No Significant Impact (FONSI).

On February 28, 2005, MMS submitted the new structure-removal PEA and a petition for new Incidental-Take Regulations under the MMPA to NOAA Fisheries Service. After review of the petition and PEA, NOAA Fisheries Service published a Notice of Receipt of MMS's Petition in the *Federal Register* on August 24, 2005. Only one comment was received by NOAA Fisheries Service during the public comment period. On April 7, 2006, NOAA Fisheries Service published the Proposed Rule for the Incidental Take of marine mammals under the MMPA in the *Federal Register*. The subsequent public comment period ended May 22, 2006, and MMS expects the Final Rule to be published in the *Federal Register* in late 2006. In addition, NOAA Fisheries Service is also conducting a Section 7 Endangered Species Act (ESA) Consultation on their MMPA rulemaking efforts. The agency expects to issue a new BiO and ITS to supersede the current "generic" and "de-minimus" BiO's around the same timeframe as the publication of the Final MMPA rule.

In water depths greater than 800 m (2,625 ft), OCS regulations would offer the lessees the option to avoid the jetting by requesting alternate removal depths for well abandonments (30 CFR §250.1716(b)(3)) and facilities (30 CFR §250.1728(b)(3)). Above mudline cuts would be allowed with reporting requirements on the remnant's description and height off of the seafloor to MMS—data necessary for subsequent reporting to the U.S. Navy. In some cases, industry has indicated that it could use the alternate removal depth options, coupled with quick-disconnect equipment (i.e., detachable risers, mooring disconnect systems, etc.) to fully abandon in-place wellheads, casings, and other minor, subsea equipment in deep water without the need for any severing devices.

After bottom-founded objects are severed and the structures are removed, operators are required to verify that the site is clear of any obstructions that may conflict with other uses of the OCS. The MMS NTL 98-26, "Minimum Interim Requirements for Site Clearance (and Verification) of Abandoned Oil and Gas Structures in the GOM," provides the requirements for site clearance. The lessee must develop, and submit to the MMS for approval, a procedural plan for the site clearance verification procedures. For platform and caisson locations in water depths of less than 91 m (300 ft), the sites must be trawled over 100 percent of the designated area in two directions (i.e., N-S and E-W). Individual well-site clearances may use high-frequency (500 kHz) sonar searches for verification. Site-clearance verification must take place within 60 days after structure removal operations have been conducted.

Proposed Action Scenario: **Tables 4-2 and 4-3** show platform removals by water-depth subarea as a result of the proposed actions. Of the 20-31 production structures estimated to be removed as a result of a WPA proposed action, 11-17 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives. Of the 24-35 production structures estimated to be removed as a result of a CPA proposed action, 14-16 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives. It is anticipated that multiple appurtenances will not be removed from the seafloor if placed in waters exceeding 800 m (2625 ft). An estimate of the well stubs and other various subsea structures that may be removed using explosives is not possible at this time.

OCS Program Scenario: **Tables 4-4, 4-5, and 4-6** show platform removals by water-depth subarea for the total OCS Program and by planning area. The number of production structures estimated to be removed during 2007-2046 is about twice the number of production structures estimated to be installed during the same time period. Of the 1,072-1,148 production structures estimated to be removed from the WPA during 2007-2046, 738-775 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives. Of the 4,925-4,949 production structures estimated to be removed from the CPA during 2007-2046, 3,487-3,495 production structures (installed landward of the 800-m isobath) are likely to be removed using explosives. No production structures are projected to be installed or removed in the EPA. It is anticipated that multiple appurtenances will not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft). An unknown number of well stubs and subsea structures may be removed using explosives; an estimate is not possible at this time.

4.1.2. Coastal Impact-Producing Factors and Scenario

4.1.2.1. Coastal Infrastructure

The following sections discuss OCS-related coastal infrastructure: service bases, helicopter hubs, construction facilities, processing facilities, terminals, disposal and storage facilities for offshore operations, coastal pipelines, coastal barging, and navigation channels. Projected new coastal infrastructure as a result of the OCS Program is shown in **Table 4-9** by state. For most of these infrastructure types, no new facilities are projected as a result of a proposed action; however, a proposed action may contribute to the use of existing and projected facilities.

It is assumed that the Louisiana DNR's existing procedures to identify potential regulatory and restoration conflicts would continue to be utilized. Those existing procedures include requirements that any project proposed within ¼ mi from either an active or proposed restoration project be reviewed to determine if it would interfere or have adverse effects on the restoration project (USDOE, 2004). Therefore, new coastal infrastructure that would result from a proposed action or the OCS Program would not interfere with active or proposed restoration projects.

4.1.2.1.1. Service Bases

The proposed actions are expected to impact only those ports that currently have facilities needed for use by the oil and gas industry as offshore service bases. A service base is a community of businesses that load, store and supply equipment, supplies and personnel that are needed at offshore work sites. Although a service base may primarily serve the OCS planning area and EIA's in which it is located, it may also provide significant services for the other OCS planning areas and EIS's. **Table 3-31** shows the 50 services bases the OCS currently uses. These facilities were identified as the primary service base by platform plans received by MMS. The ports of Fourchon, Cameron, Venice, and Morgan City, Louisiana, are the primary service bases for GOM mobile rigs. Major platform service bases are Galveston, Freeport, and Port O'Connor, Texas; Cameron, Fourchon, Intracoastal City, Morgan City, and Venice, Louisiana; Pascagoula, Mississippi; and Theodore, Alabama. As noted in **Chapter 3.3.5.2**, both Venice and Cameron were hard hit by the 2005 hurricane season, and neither city is close to being fully operational as of September 2006. However, both intend to be back online and competitive in the future, long before any impacts associated with the proposed actions would occur.

As the industry continues to evolve, so do the requirements of the onshore support network. With advancements in technology, the shore-side supply network will continue to be challenged to meet the needs and requirements of the industry. All supplies must be transported from land-based facilities to marine vessels or helicopters to reach offshore destinations. This utilizes both water and air transportation modes. The intermodal nature of the entire operation gives ports (which traditionally have water, rail, and highway access) a natural advantage as an ideal location for onshore activities and intermodal transfer points. Therefore, ports will continue to be a vital factor in the total process and must incorporate the needs of the offshore oil and gas industry into their planning and development efforts particularly with regard to determining their future investment needs. In this manner both technical and economic determinants must influence the dynamics of port development.

Issues and concerns that must be addressed at the local level have resulted from the significant prosperity that has followed the industry. These extend beyond specific port needs into the community itself. Most of these problems can be nullified with additional infrastructure. However, additional infrastructure is difficult to develop. It is expensive to construct and requires substantial planning and construction time prior to completion. Rapidly developing technology has resulted in changing needs for the offshore oil and gas industry. This has placed a burden on the ports to provide the necessary infrastructure and support facilities required to meet the needs of the industry in a timely manner.

To continue to offer a viable service and to stay current with technological trends and industry standards, ports must be able to incorporate offshore oil and gas industry information into their planning for future infrastructure development, staffing needs, and other impacts associated with rapid industrial growth. Expansion of some existing service bases is expected to occur to capture and accommodate the current and future oil and gas business that is generated by development on the OCS and State waters. Some channels in and around the service bases will be deepened and expanded in support of deeper draft vessels and other port activities, some of which will be OCS related.

As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range, faster speed, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation systems; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m (20-26 ft).

Proposed Action Scenario: A proposed action will not change identified service bases or require any additional service bases.

OCS Program Scenario: The OCS Program activities will continue to lead to a consolidation of port activities at specific ports especially with respect to deepwater activities (i.e., Port Fourchon and Galveston). The OCS Program will require no additional service bases.

4.1.2.1.2. Helicopter Hubs

Helicopter hubs or "heliports" are facilities where helicopters can land, load, and offload passengers and supplies, refuel, and be serviced. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Most of the helicopter operations originate at helicopter hubs in coastal Texas and Louisiana. There are approximately 247 heliports within the Gulf region that support OCS activities; 122 are located in Texas, 81 in Louisiana, 34 in Florida, 6 in Mississippi, and 4 in Alabama (The Louis Berger Group, Inc., 2004). Three helicopter companies dominate the GOM offshore helicopter industry: Bristow Group (formerly Offshore Logistics), Era Aviation (Era), and PHI (formerly Petroleum Helicopters, Inc). A few major oil companies operate and maintain their own fleets, although this is a decreasing trend. Instead of running their own fleets, oil and gas companies are increasingly sub-contracting the whole operation on a turnkey basis to independent contractors. More and more operations are outsourcing to oil-field support companies, such as Baker Hughes, who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

To meet the demands of deep water (travel farther and faster, carry more personnel, be all-weather capable, and have lower operating cost), the offshore helicopter industry is purchasing new helicopters. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore.

Proposed Action Scenario: Helicopter operations projected for a proposed action in the WPA are 400,000-900,000 operations (**Table 4-2**). This equates to an average annual rate of 10,000-22,500 operations. A proposed action in the CPA is projected to generate 1,000,000-2,200,000 helicopter operations or 25,000-55,000 operations annually (**Table 4-3**).

OCS Program Scenario: Minimal helicopter hub construction or closures are anticipated. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore. No new heliports are projected as a result of the OCS Program; however, they may expand at current locations. The projected number of helicopter operations for the OCS Program is 38,000,000-60,000,000 operations over the 2007-2046 period (**Table 4-4**). This equates to an average rate of 950,000-1,500,000 operations annually.

4.1.2.1.3. Construction Facilities

4.1.2.1.3.1. Platform Fabrication Yards

Given the platform fabrication industry characteristics and trends therein, it is not likely that new yards will emerge. The existing fabrication yards do not operate as "stand alone" businesses, rather they rely heavily on a dense network of suppliers of products and services. Also, since such a network has been historically evolving in Louisiana and Texas for over 50 years, the existing fabrication yards possess a compelling force of economic concentration to prevent the emergence of new fabrication yards. There are 43 platform fabrication yards in the analysis area.

With respect to the deepwater development, the challenges for the fabrication industry stem from the greater technical sophistication and the increased project complexity of the deepwater structures, such as compliant towers and floating structures. The needs of the deepwater projects are likely to result in two important trends for the fabrication industry. The first is the increasing concentration in the industry, at least with respect to the deepwater projects. As technical and organizational challenges continue to mount up, it is expected that not every fabrication yard will find adequate resources to keep pace with the demands of the oil and gas industry. The second trend is the closer integration—through alliances, amalgamations, or mergers—among the fabrication yards and engineering firms.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. Some current yards may close, be bought out, or merge over the 2007-2046 period resulting in fewer active yards in the analysis area.

4.1.2.1.3.2. Shipyards

The 1980's were dismal for the shipbuilding industry. Several mergers, acquisitions, and closings occurred during the downturn. Of those that have remained, 94 are located within the analysis area

(**Table 3-38**). Several large companies dominate the oil and gas shipbuilding industry. Most yards in the analysis area are small. To a great extent, growth will be based on a successful resolution of several pertinent issues that have affected and will continue to affect shipbuilding in the U.S. and particularly in the analysis area: maritime policy, declining military budget, foreign subsidies, USCG regulations, OPA 90, financing, and an aging fleet.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. Some current yards may close, be bought out, or merge over the 2007-2046 period, which would result in fewer active yards in the analysis area.

4.1.2.1.3.3. Pipecoating Facilities and Yards

There are currently 19 pipecoating plants in the analysis area (**Table 3-38**). Pipe-coating facilities receive manufactured pipe, which they then coat the surfaces of with metallic, inorganic, and organic materials to protect from corrosion and abrasion and to add weight to counteract the water's buoyancy. Two to four sections of pipe are then welded at the plant into 40-ft segments. The coated pipe is stored (stacked) at the pipeyard until it is needed offshore.

To meet deepwater demand, pipecoating companies have been expanding capacity or building new plants. A new trend in the industry is single-source contracts where the pipe manufacturing, coating, welding and laying are all under one contract. This results in a more efficient, less costly operation. At present, though, only foreign companies have this capability.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action.

OCS Program Scenario: Current capacity, supplemented by recently built plants and expansions, are anticipated to meet OCS Program demand. No new facilities are expected to be constructed in support of OCS Program activities.

4.1.2.1.4. Processing Facilities

4.1.2.1.4.1. Refineries

A refinery is an organized arrangement of manufacturing units designed to produce physical and chemical changes to turn crude oil into petroleum products. In the refinery, most of the nonhydrocarbon substances are removed from crude oil and it is broken down into its various components, and blended into useful products.

In the early 1980's, the Crude Oil Entitlements Program ended and crude oil prices were no longer controlled. This caused the number of petroleum refineries to drop sharply leading to 13 years of decline in U.S. refining capacity. The decade of the 1990's was characterized by low product margins and low profitability. Refining operations were consolidated, the capacity of existing facilities was expanded, and several refineries were closed. Most refineries are part of major, vertically integrated oil companies that are engaged in both upstream and downstream aspects of the petroleum industry. These companies dominate the refining industry, although most majors are spinning off their refinery facilities to independents or entering joint ventures to decrease the risk associated with low refining returns. One-third of operable U.S. petroleum refineries are located in the Gulf States of Alabama, Louisiana, Mississippi, and Texas. Most of the region's refineries are located in Texas and Louisiana (**Table 3-38**). Texas has 25 operating refineries, with a combined crude oil capacity of 4.6 MMbbl/day, while Louisiana has 17 operating refineries with 2.8 MMbbl/day of capacity, representing 27.2 and 16.3 percent, respectively, of total operating U.S. refining capacity.

Two significant environmental considerations facing U.S. refiners are Phase 2 Clean Air Act Amendments (CAAA) of 1990 reformulated motor gasoline (RFG) requirements and the growing public opposition to the use of methyl tertiary butyl ether (MTBE). In order to meet Phase 2 RFG requirements, U.S. refiners will incur numerous expenses and make substantial investments. The MTBE is an additive that increases the oxygen content of motor gasoline causing more complete combustion of the fuel and less pollution. It was a relative inexpensive way for refiners to meet Phase 1 CAAA RFG requirements.

Since March 1999, 19 states have adopted partial or complete bans on the use of MTBE because of concerns about groundwater contamination (USEPA, 2004c). This will cause additional outlays of money and some restructuring of current facilities in order to move to ethanol.

Distillation capacity is projected to grow from the 2004 year-end level of 16.9 million barrels per day to 18.5 million barrels per day in 2025 and 19.3 million barrels per day in 2030 (USDOE, EIA, 2006n). All most all capacity additions are expected to occur on the Gulf Coast. Financial, environmental, and legal considerations make it unlikely that new refineries will be built in the United States; therefore, expansion at existing refineries likely will increase total U.S. refining capacity in the long run. Refineries will be continued to be utilized intensely, from 93 percent in 2004 to 95 percent in 2030 (USDOE, EIA, 2006n).

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a WPA or CPA proposed action.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. While financial, environmental, and legal considerations make it unlikely that new refineries will be built in the U.S., expansion at existing refineries likely will increase total U.S. refining capacity over the 2007-2046 period.

4.1.2.1.4.2. Gas Processing Plants

After raw gas is brought to the earth's surface, it is processed at a gas processing plant to remove impurities such as water, carbon dioxide, sulfur, and inert gases and transformed into a saleable, useable energy source. The total number of natural gas processing plants operating throughout the U.S. has been declining over the past several years as companies have merged, exchanged assets, and closed older, less efficient plants. However, this trend was reversed in 1999. Louisiana, Mississippi, and Alabama's capacity is undergoing significant increases as a wave of new plants and expansions try to anticipate the increased coming ashore from new gas developments in the GOM. At present, there are 249 gas processing plants in the Gulf States, representing 58 percent of U.S. gas processing capacity. The distribution of these plants by state is shown in **Table 3-38**.

According to a study published by the Gas Research Institute, offshore GOM is the only area of the U.S. that offers potential new gas supplies for gatherers/processors. This is also the only region where any significant exploration is occurring. Gas processing facilities were forecasted by examining the current fleet of facilities and their existing capacities relative to the projected processing needs over the life of the proposed actions (i.e. over the next 40 years). All facilities in the analysis area were identified and grouped by the state in which they operate, and all analyses were done at the State level. Facilities with capacities under 1 Bcf/d were assumed to be, on average, older than those with capacities greater than 1 Bcf/d because many of these larger facilities have been constructed within the last decade, while smaller facilities and straddle plants are parts of the existing pipeline system and tend to have been in service for a longer time period. Facilities were then depreciated using straight-line deprecation of remaining life, where smaller facilities were assumed to have 35-year live spans and larger facilities were assumed to have 40-year life spans (on average). Facility capacities were then compared with existing gas production, which was assumed to decline over time according to historic trends. New production forecasted as a result of each of the proposed actions was then added to historic production to determine overall production needed to be processed. Gas production was then compared with net depreciated gas processing capacity to determine the needed capacity to meet future production. Any new processing plants forecasted were assumed to have a facility size of 1.75 Bcf/d.

The MMS anticipates the construction of as many as 14 new gas-processing plants in the analysis area to process OCS gas (**Table 4-9**). Of these new plants, two are expected to be located in Texas, three in Louisiana, and nine in the Mississippi-Alabama area.

Proposed Action Scenario: At present, there is considerable excess gas capacity in the GOM. However, near the end of the life of the proposed action, 0-1 new facilities are expected to be constructed as a result of a WPA or CPA proposed action.

OCS Program Scenario: Because of the potential for gas in the GOM OCS, MMS anticipates 14 new gas processing plants will be constructed in the analysis area in support of OCS Program activities. These gas processing additions are the result of new activities in the GOM as well as the depreciation and replacement of the existing facilities in the area. As these facilities age, there will be increasing need to either make significant capital additions, usually increasing the processing capacity of the facility, and/or the development of new facilities. The MMS anticipates fewer individual facilities operating in the future; however, the average facility size is expected to increase.

4.1.2.1.5. Terminals

4.1.2.1.5.1. Pipeline Shore Facilities

The term "pipeline shore facility" is a broad term describing the onshore location where the first stage of processing occurs for OCS pipelines carrying different combinations of oil, condensate, gas, and produced water (**Chapter 3.3.5.8.6.1**). Some processing may occur offshore at the platform; only onshore facilities are addressed in this section. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to the gas processing plant (**Chapter 4.1.2.1.4.2**); therefore, new pipeline shore facilities are projected to only result from oil pipeline landfalls. A pipeline shore facility may support one or several pipelines; therefore, new pipeline shore facilities are projected to only result from larger pipelines (>12 in). Although older facilities may be located in wetlands, current permitting programs prohibit or discourage companies from constructing any new facilities in wetlands.

Proposed Action Scenario: No new pipeline shore facilities are projected as a result of a proposed action. It is projected that the proposed actions would represent a small percent of the resources handled by existing and projected shore facilities.

OCS Program Scenario: As a result of the OCS Program, new shore facilities may be needed to support new larger oil pipeline landfalls. A total of 4-6 new pipeline shore facilities are projected as a result of the OCS Program (1-2 for the OCS Program in the WPA and 3-4 in the CPA).

4.1.2.1.5.2. Barge Terminals

Barging of OCS production is expected to remain stable. No major modifications or new barge terminals are expected to be constructed in the foreseeable future to support proposed-action or OCS-Program operations.

4.1.2.1.5.3. Tanker Port Areas

The transport of OCS-produced oil from FPSO operations to inside or shore-side facilities would be accomplished with shuttle tankers rather than oil pipelines. The following tanker ports were identified as destinations for shuttle tankers transporting crude oil from FPSO operations in the GOM: Corpus Christi, Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, the lower Mississippi River ports (Baton Rouge, Port of South Louisiana, New Orleans, and Plaquemines), and the Louisiana Offshore Oil Port, Louisiana. These ports were selected based on their location to refineries and channel depth.

The number of shuttle-tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000-bbl capacity, offloading would occur once every 3.3 days. This would equate to 54.75 MMbbl of production with 110 offloading events and shuttle-tanker transits to Gulf coastal or offshore ports annually per FPSO.

WPA Proposed Action Scenario: Up to 330 offloading operations and shuttle tanker transits are estimated to occur annually during the peak years of FPSO use as a result of the WPA proposed action. Destinations for shuttle tankers transporting crude oil from FPSO operations in the WPA will be Corpus Christi, Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, Louisiana. Tanker trips associated with the WPA proposed action activities would represent a small percentage of annual tanker trips into identified tanker ports.

CPA Proposed Action Scenario: Up to 330 offloading operations and shuttle tanker transits are estimated to occur annually during the peak years of FPSO use as a result of the CPA proposed action. Destinations for the majority of shuttle tankers transporting crude oil from FPSO operations in the CPA will be Mississippi River ports and the Louisiana Offshore Oil Port, Louisiana. Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, Louisiana, will be used to a lesser extent.

Tanker trips associated with the CPA proposed action activities would represent a small percentage of annual tanker trips into identified tanker ports.

OCS Program Scenario: Up to 1,210 offloading operations and shuttle tanker transits will occur annually during the peak years of FPSO use as a result of the OCS Program in the WPA and CPA. Destinations for the majority of shuttle tankers transporting crude oil from FPSO operations in the GOM will be Mississippi River ports and the Louisiana Offshore Oil Port, Louisiana. Corpus Christi, Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, Louisiana, will be used to a lesser extent. Tanker trips associated with the OCS Program activities would represent a small percentage of annual tanker trips into identified tanker ports.

4.1.2.1.6. Disposal and Storage Facilities for Offshore Operational Wastes

Both the GOM offshore oil and gas industry and the oil and gas waste management industry are undergoing significant changes. New drilling technologies and policy decisions as well as higher energy prices should increase the level of OCS activity and, with it, the volumes of waste generated. The oil-field waste industry, having been mired in somewhat stagnant conditions for almost two decades, has developed new increments of capacity, and some new entrants into the market have added to industry capacity and the diversity of technologies available for the industry to use.

Facilities that accept OCS-generated waste such as municipal waste landfills and hazardous waste treatment, storage and disposal facilities, are diverse and manage waste for the broad base of U.S. industry. The OCS activity does not generate a large part of the waste stream into these facilities and is not expected to be material to the overall capacity of the industry. Capacity of industrial waste management facilities is for the most part abundant, as U.S. industries have learned to minimize wastes they ship to offsite facilities for management.

Proposed Action Scenario: No new disposal and storage facilities will be built as a result of a WPA or CPA proposed action.

OCS Program Scenario: No new disposal and storage facilities are expected to be constructed in support of OCS Program activities.

4.1.2.1.6.1. Nonhazardous Oil-field Waste Sites

Long-term capacity to install subsurface injection facilities onshore is itself not scarce and oilfield waste injection well permits do not generally attract much public opposition. With the volume of produced water frequently exceeding the volume of oil a well produces by tenfold or more, the main limitation to widespread use of land-based subsurface injection facilities is the space at docks and the traffic in and out of ports.

With the addition of Trinity Field Services to the market, the OCS market has its first salt dome disposal operation in a competitive location, with 6.2 million barrels of space available initially. This is enough capacity to take 8-10 year's worth of OCS liquids and sludges at current generation rates and a potential of several times that amount with additional solution mining. Salt domes are well-known and well-documented geological structures, and others could be placed into service as demand dictates. Salt caverns are a finite resource, but nevertheless have the potential to take decades' worth of OCS offsite NOW generation.

Proposed Action Scenario: No new NOW waste sites will be built as a result of a WPA or CPA proposed action. Capacity to manage waste generated by a proposed action's drilling and production activities is adequate for the present.

OCS Program Scenario: No new NOW waste sites will be built as a result of the OCS Program. Oil and gas waste management facilities along the Gulf Coast have adequate capacity and for a hypothetical future that includes a doubling of current waste volumes.

4.1.2.1.6.2. Landfills

The use of landfarming of OCS waste is likely to decline further, particularly with greater availability of injection methods for wastes containing solids. Future regulatory efforts are likely to discourage the practice by adding requirements that damage the economics, if not by an outright ban on future permits.

Even though growth in OCS waste volumes can be expected to follow a linear relationship with increased OCS drilling and production activity, landfills will continue to be a small factor in the reduction of trash generated by OCS activity. Some of the platforms destroyed by Hurricanes Katrina and Rita will be sunk to create artificial reefs, and some of the materials will be recycled; however, a large part of these destroyed platforms and rigs will likely wind up in Gulf Coast landfills. This volume, however, is not enough to change the conclusions below.

Proposed Action Scenario: No new landfills will be built as a result of a WPA, or CPA proposed action.

OCS Program Scenario: No new landfill waste sites will be built as a result of the OCS Program. Landfills are a small factor in the reduction of trash generated by OCS activity.

4.1.2.1.7. Coastal Pipelines

This section discusses OCS pipelines in coastal waters (State offshore and inland waters) and coastal onshore areas. See **Chapter 4.1.1.8.1** for a discussion of pipelines in Federal offshore waters. The OCS pipelines near shore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland. See **Chapter 4.1.3.1.2** for a discussion of pipelines supporting State oil and gas production.

Pipelines in coastal waters may present a hazard to commercial fishing where bottom-trawling nets are used; this is one reason that pipelines must be buried in waters less than 60 m (200 ft). Pipeline burial is also intended to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, and to minimize interference with the operations of other users of the OCS. For the nearshore sections of OCS pipelines, USCOE and State permits for constructing pipelines require that turbidity impacts to submerged vegetation be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment.

Increasing, the trend is for new OCS pipelines to tie into existing systems rather than creating new landfalls. Over the last 10 years, there has been an average of slightly over one new OCS pipeline landfall per year. As a mitigation measure to avoid adverse effects of barrier beaches and wetlands, most pipeline landfalls crossing barrier beaches and wetlands will be directionally bored under them.

About 20 percent of OCS pipelines making landfall are inactive or abandoned; some of these may have been or will be reactivated for OCS-related use. Pipelines may be abandoned in place if they do not constitute a hazard to navigation and commercial fishing or unduly interfere with other uses of the OCS.

Preliminary results from the MMS/USGS National Wetland Research Center's (NWRC) current study of coastal wetland impacts from pipeline construction and associated widening of canals utilizing USGS habitat data are summarized below (Johnston and Barras, personal communication, 2002):

> Approximately 15,400 km (9,570 mi) of OCS pipelines have been constructed in Louisiana from the 3-mi State/Federal boundary to the CZM boundary. Of those pipelines, approximately 8,000 km (4,971 mi) crossed wetland (marsh) or upland habitat. The remaining 7,400 km (4,598 mi) crossed waterbodies. Sources of OCS pipeline data were Penn Well Mapsearch, MMS, National Pipeline Mapping System, and the Geological Survey of Louisiana pipeline datasets. Additionally, based on USGS 1978 habitat data, approximately 56 percent of the length of pipelines crossed marsh habitat and 44 percent crossed upland habitat. Using USGS landloss data from 1956 to 2002 within a 300-m (984-ft) buffer zone (150 m (492 ft) on each side of the pipeline), the total amount of landloss attributed to OCS pipelines was 34,400 ha (85,968 ac). This number represents 0.04 km^2 (4.00 ha, 9.88 ac) per linear km of pipeline installed. When one divides 34,400 ha (85,968 ac) by the 46-year period (1956-2002), the loss per year is 746 ha (1,843 ac) for the 8,000 km (4,971 mi) of OCS pipeline. This represents 11.9 percent of the total landloss in the Louisiana pipeline study area. Note that from the period 1990-2002 (based on the preliminary data by USGS), the total landloss due to pipelines for the study area was approximately 25 km^2 (~10 mi^2) or 525 ac/yr, which represents a dramatic decline from the 1956-1978 and 1978-1990 analysis periods. Many of these pipelines were installed prior to the implementation of NEPA in 1969 and the State of Louisiana's Coastal Permit Program in 1981. Additionally, given the width of the buffer, 300 m (984

ft) versus actual pipeline-canal width, which may be 31-61 m (100-200 ft) wide, an unknown portion of the increase in open water is attributed to other factors unrelated to OCS pipelines. To address this, selected OCS pipelines are being studied in greater detail to ascertain direct and secondary impacts to the extent possible and the information from that analysis will be included in future NEPA documents.

Technologies have been and continue to be developed that decrease the impacts of OCS pipelines on wetlands and associated sensitive habitat. For example, the proposed 30-in Endymion pipeline would deliver crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field. Based on a review of the data in the COE permit application (No. 20-020-1632), the pipeline construction would have zero (0) impacts to marshes (emergent wetlands) and beaches because the operator is using horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the proposed route traverses open water to the extent possible.

WPA Proposed Action Scenario: Based on the projected number of platforms and production, 1-3 new pipelines are projected in State waters as a result of a proposed action in the WPA. Of those pipelines, 0-1 are projected to make landfall and would result in up to 2 km (1.2 mi) of pipeline onshore in Texas.

CPA Proposed Action Scenario: Based on the projected number of platforms and production, 1-3 new pipelines are projected in State waters as a result of a proposed action in the CPA. Of those pipelines, 0-1 are projected to make landfall and would result in up to 2 km (1.2 mi) of pipeline onshore in Louisiana.

OCS Program Scenario: Increasingly, the trend is for new OCS pipelines to tie into existing systems rather than creating new landfalls. From 2007 to 2046, 80-118 new pipelines are projected in State waters as a result of the OCS Program. Of those pipelines, 32-47 are projected to make landfall (**Table 4-9**) and would result in 64-94 km (40-58 mi) of pipeline onshore.

4.1.2.1.8. Coastal Barging

It is projected that OCS oil barged from offshore platforms to onshore barge terminals will continue to represent a small portion of the total amount of oil barged in coastal waters. There is a tremendous amount of barging that occurs in the coastal waters of the GOM, and no estimates exist of the volume of this barging that is attributable to the OCS industry. Secondary barging of OCS oil often occurs between terminals or from terminals to refineries. Oil that is piped to shore facilities and terminals is often subsequently transported by barge up rivers, through the Gulf Intracoastal Waterway, or along the coast.

The current rate of OCS barging is expected to continue and is not likely to make up a significantly larger percentage of the total oil barged than what is currently occurring.

4.1.2.1.9. Navigation Channels

The current system of navigation channels around the northern Gulf is believed to be generally adequate to accommodate traffic generated by a proposed action and the future OCS Program. Gulf-to-port channels and the Gulf Intracoastal Waterway that support the prospective ports are sufficiently deep and wide enough to handle the additional traffic. As exploration and development activities increase on deepwater leases in the GOM, vessels with generally deeper drafts and longer ranges will be used as needed to support deepwater activities. Therefore, several OCS-related port channels may be deepened or widened during the life of a proposed action to accommodate deeper draft vessels. Typically, no channel deeper than 8 m (26 ft) will be needed to accommodate these deeper draft vessels.

Proposed Action Scenario: Current navigation channels will not change as a result of a WPA or CPA proposed action. In addition, no new navigation channels will be required by a WPA or CPA proposed action.

OCS Program Scenario: A few OCS-related port channels may be deepened or widened during the 2007-2046 period to accommodate deeper draft vessels necessary for deepwater development. The OCS Program will require no new navigation channels.

4.1.2.2. Discharges and Wastes

4.1.2.2.1. Onshore Facility Discharges

The primary onshore facilities that support offshore oil and gas activities include service bases, helicopter hubs at local ports/service bases, construction facilities (platform fabrication yards, pipeyards, shipyards), processing facilities (refineries, gas processing plants, petrochemical plants), and terminals (pipeline shore facilities, barge terminals, tanker port areas). A detailed description of these facilities is given in **Chapter 3.3.5.8**, OCS-Related Coastal Infrastructure. Water discharges from these facilities are from either point sources, such as a pipe outfall, or nonpoint sources, such as rainfall run-off from paved surfaces. The USEPA or the USEPA-authorized State program regulates point-source discharges as part of NPDES. Facilities are issued general or individual permits that limit discharges specific to the facility type and the waterbody receiving the discharge. Other wastes generated at these facilities are handled by local municipal and solid waste facilities, which are also regulated by USEPA or an USEPA-authorized State program.

4.1.2.2.2. Coastal Service-Vessel Discharges

Operational discharges from vessels include sanitary and domestic waters, bilge waters, and ballast waters. Support-vessel operators servicing the OCS offshore oil and gas industry may still legally discharge oily bilge waters in coastal waters, but they must treat the bilge water to limit its oil content to 15 ppm prior to discharge. Ballast water may be subject to the USCG Ballast Water Management Program to prevent the spread of aquatic nuisance species (*Federal Register*, 2004). Sanitary wastes are treated on-board ships prior to discharge. State and local governments regulate domestic or gray water discharges.

4.1.2.2.3. Offshore Wastes Disposed Onshore

All wastes that are not permitted to be discharged offshore by USEPA must be transported to shore or reinjected downhole. Additionally, wastes may be disposed of onshore because they do not meet permit requirements or onshore disposal is economically advantageous. Most OBF muds are recycled, and OBF cuttings are disposed of onshore. Both USEPA Regions 4 and 6 permit the discharge of SBF wetted cuttings, provided the cuttings meet the criteria with regard to percent SBF retained, PAH content, biodegradability, and sediment toxicity. The SBF fluid is either recycled or transferred to shore for regeneration and reuse or disposal. Drill cuttings contaminated with hydrocarbons from the reservoir fluid must be disposed of onshore or reinjected.

The USEPA allows TWC fluids to be commingled with the produced-water stream if the combined produced-water/TWC discharges pass the toxicity test requirements of the NPDES permit. Facilities with less than 10 producing wells may not have enough produced water to be able to effectively commingle the TWC fluids with the produced-water stream to meet NPDES requirements (USEPA, 1993a and b). Spent TWC fluid is stored in tanks on tending workboats or is stored on platforms and later transported to shore on supply boats or workboats. Once onshore, the TWC wastes are transferred to commercial waste-treatment facilities and disposed in commercial disposal wells. Offshore wells are projected to generate an average volume of 200 bbl from either a well treatment or workover job every 4 years. Each new well completion would generate about 150 bbl of completion fluid.

Current USEPA NPDES general permits prohibit operators in the GOM from discharging any produced sands offshore. Cutting boxes (15- to 25-bbl capacities), 55-gallon steel drums, and cone-bottom portable tanks are used to transport the solids to shore via offshore service vessels. Total produced sand from a typical platform is estimated to be 0-35 bbl/day (USEPA, 1993a and b). Both Texas and Louisiana have State oversight of exploration and production (E&P) waste management facilities (Veil, 1999).

4.1.2.2.4. Beach Trash and Debris

According to USEPA, there are two different sources from which debris pollutes our oceans: land-based and ocean-based. The first source, land-based, causes 80 percent of the marine debris found on our beaches and waters. Additionally, sources of land-based marine debris includes beachgoers, storm-water runoff, landfills, solid waste, rivers, floating structures, ill-maintained garbage bins, and litterbugs. The Ocean Conservancy (formerly the Center for Marine Conservation) reports that beachgoers are a prime source of beach pollution, leaving over 75 tons of trash per week. Marine debris also comes from combined sewer overflows and typically includes medical waste, street litter, and sewage. The second source of marine debris is from ocean sources, and this type of debris includes galley waste and other trash from ships, recreational boaters, fishermen, and offshore oil and gas exploration and production facilities. Commercial and recreational fishers produce trash and debris by discarding plastics (e.g., ropes, buoys, fishing line and nets, strapping bands, and sheeting), wood, and metal traps. Some trash items, such as glass, pieces of steel, and drums with chemical or chemical residues, can be a health threat to local water supplies, to beachfront residents, and to users of recreational beaches. To compound this problem, there is population influx along the coastal shorelines. These factors, combined with the growing demand for manufactured and packaged goods, have led to an increase in nonbiodegradable solid wastes in our waterways (USEPA, 2006c).

The Ocean Conservancy sponsors both the International Beach Cleanup (ICC) as well as the National Marine Debris Monitoring Program (MDP). The ICC is supported by the USEPA, and the first cleanup was in 1986 in Texas. The campaign currently involves all of the states and territories of the U.S. and more than 100 countries around the world. The ICC is the largest volunteer environmental data-gathering effort and associated cleanup of coastal and underwater areas in the world. It takes place every year on the third Saturday in September. The September 18, 2004, cleanup brought out over 300,000 citizens of 88 countries to help clean over 11,000 mi (17,703 km) of shoreline. Volunteers removed nearly 8 million pounds of trash, litter, and debris worldwide. In the U.S., 158,000 volunteers from 49 states and territories cleaned over 8,000 mi of beaches, streams and riverbanks. To address the marine debris problem, USEPA teamed up with the Ocean Conservancy to create the MDP, which began establishing marine debris monitoring sites along the GOM. The program began in 1996 with the establishment of 40 monitoring sites from the Texas/Mexico border to Port Everglades, Florida, and included Puerto Rico and the U.S. Virgin Islands. To date, the MDP has nearly 700 volunteers in 19 coastal states and two U.S. territories monitoring marine debris at over 130 marine debris-monitoring sites. Additionally, 163 study sites have been designated and 128 sites are collecting data (The Ocean Conservancy, 2005; USEPA, 2006c).

Texas has been collecting coastal debris for over 20 years. The Texas event is coordinated by the Texas General Land Office's Adopt a Beach Program. The Adopt a Beach Program celebrated its 20th anniversary in 2005. Twice a year the Adopt a Beach Program holds cleanups all along the Texas coast. During the 2005 fall cleanup, 6,401 volunteers covered over 177 mi. The volunteers picked up 235,035 pounds of debris (Texas General Land Office, 2005b).

The Louisiana event is coordinated by the Louisiana Department of Environmental Quality (LADEQ), Litter Reduction and Public Action Program. During the 2004 Louisiana Beach Sweep and Inland Waterway Cleanup, 2,045 volunteers came to clean up shorelines and waterways. Volunteers covered 72 mi and picked up 56,619 pounds of debris. The 2005 Louisiana Beach Sweep and Inland Waterway Cleanup were canceled because of Hurricanes Katrina and Rita (LADEQ, 2006).

The Mississippi Marine Debris Task Force sponsors the annual Mississippi Coastal Cleanup. In 2003, approximately 4,513 volunteers picked up trash along 233 mi of coastal waterways and the barrier islands during the Mississippi Coastal Cleanup. Volunteers collected 72,988 pounds of trash. The 2004 and 2005 cleanups were canceled because of Hurricane Ivan in 2004 and Hurricanes Katrina and Rita in 2005 (Mississippi Alabama Sea Grant Consortium, 2006).

The Alabama Coastal Cleanup is coordinated through the Alabama Department of Conservation and Natural Resources, State Lands Division, Coastal Section and the Alabama People Against a Littered State. Alabama joined this effort in 1987. Since then, 41,946 participants in Alabama have removed a total of 746,850 pounds of debris and cleaned 2,182 mi of coast. Because of Hurricane Katrina, some cleanup zones for the September 17, 2005, event were canceled (Alabama Coastal Cleanup, 2006).

The 2005 hurricane season also disrupted Florida's cleanup efforts. However, in 2004, 15,121 Florida residents participated in the International Coastal Cleanup. The volunteers covered 871 mi of shoreline and picked up 284,436 pounds of trash. The Florida Coastal Cleanup started in Florida in 1988 and went international in 1989. It has grown to 52 main cleanup zones in Florida (International Coastal Cleanup, 2005).

4.1.2.3. Noise

Coastal noise associated with OCS oil and gas development results from helicopter and service-vessel traffic. Sound generated from these activities can be transmitted through both air and water, and may be continuous or transient. The intensity and frequency of the noise emissions are highly variable, both between and among these sources. The level of underwater sound detected depends on receiver depth and aspect, and the strength/frequencies of the noise source. The duration that a passing airborne or surface sound source can be received underwater may be increased in shallow water by multiple reflections (echoes).

Service vessels and helicopters (discussed also in **Chapters 4.1.1.8.4 and 4.1.1.8.5**) may add noise to broad areas. Sound generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity.

Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward, and the underwater noise is generally brief in duration, compared with the duration of audibility in the air. Water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area. A range of 10,000-22,500 helicopter operations (take off and landing) is projected to occur annually as a result of a proposed action in the WPA. A range of 25,000-55,000 helicopter operations is projected to occur annually as a result of a proposed action in the CPA.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Broadband source levels for most small ships (e.g., support and supply ships) are ~170-180 dB re 1 μPa (Richardson et al., 1995). Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Noise increases with ship speed; ship speeds are often reduced in restricted coastal waters and navigation channels. A range of 2,350-3,875 service-vessel round trips is projected to occur annually as a result of a proposed action in the WPA. About 2,925-5,975 service-vessel trips are projected to occur annually as a result of a proposed action in the CPA.

4.1.3. Other Cumulative Activities Scenario

4.1.3.1. State Oil and Gas Activities

4.1.3.1.1. Leasing and Production

Texas

The Railroad Commission of Texas is the agency charged by the Texas Legislature with the regulation of the oil and gas industry in the State of Texas. The Lands and Minerals Division of the Texas General Land Office holds lease sales quarterly in January, April, July, and October. Sales are usually held on the first Tuesday of the month; however, the January and July sales have been held in recent years on the second Tuesday of the month because of holidays.

Louisiana

The Office of Mineral Resources holds regularly scheduled lease sales on the second Wednesday of every month. As in Texas, the State of Louisiana's offshore oil and gas leasing program is conducted on a regular basis irrespective of the Federal OCS mineral leasing program.

In recent years, oil and gas production in the State of Louisiana, as in Texas, has been declining. The MMS projects that the State's offshore production would continue this trend over the analysis period.

Mississippi

The State of Mississippi does not have an offshore oil and gas leasing program. The MMS does not expect the State to institute such a program in the near future.

Alabama

Alabama has no established schedule of lease sales. The limited number of tracts in State waters has resulted in the State not holding regularly scheduled lease sales. The last lease sale was held in 1997. The MMS does not expect the State to institute such a program in the near future.

Florida

The State of Florida has experienced very limited drilling in coastal waters. In 2005, Florida's Governor Jeb Bush and the Florida Cabinet signed a historic settlement agreement to eliminate the potential for oil drilling in State waters.

4.1.3.1.2. State Pipeline Infrastructure

The existing pipeline network in the Gulf Coast States is developed and extensive with spare capacity. Expansion is projected to be primarily small diameter pipelines to increase the interconnectivity of the existing network and a few major interstate pipeline expansions. Pipeline companies are taking steps to reduce impacts from future hurricanes by adding new interconnections to their pipeline networks to create alternate routes in case of damage to one part of the network (Federal Trade Commission, 2006). Any new larger diameter pipelines would likely be constructed to support onshore and offshore LNG terminals. However, as discussed in **Chapter 4.1.3.2.6**, Offshore Liquefied Natural Gas Projects, there is spare capacity in the existing pipeline infrastructure to move the regasified natural gas to market, and deepwater ports can serve onshore facilities including intrastate as well as interstate pipelines.

4.1.3.2. Other Major Offshore Activities

4.1.3.2.1. Dredged Material Disposal

Dredged material is described at 33 CFR 324 as any material excavated or dredged from navigable waters of the U.S. According to the USEPA, "virtually all ocean dumping occurring today is dredged material, sediments removed from the bottom of waterbodies in order to maintain navigation channels and berthing areas" (USEPA, 2006).

In response to the Marine Protection, Research, and Sanctuaries Act of 1972, as of February 1996, the USEPA finalized the designation of 27 dredged material disposal sites in the Gulf of Mexico. Another 12 sites in the Gulf were considered interim sites pending completion of baseline or trend assessment surveys and then the final designation or termination of use of these sites (40 CFR 228.14). Since then, one interim site was approved on a final basis (40 CFR 228.15). Of the 39 designated and interim sites, 11, 21, and 7 sites are located in the WPA, CPA, and EPA, respectively. These sites range in area from 0.5 mi^2 to 9 mi^2 and are all within 20 mi of shore.

The COE issues permits for ocean dumping using USEPA's environmental criteria. These permits are subject to USEPA's concurrence. Under the Clean Water Act, the USEPA requires testing of dredge material prior to its disposal to ensure there are no unacceptable adverse impacts to the marine environment.

According to the COE's Ocean Disposal Database (ODD) more than 635 million m^3 of dredged material were disposed in the GOM from 1976 to 1999, which is an average of 26 million m^3 per year (U.S. Dept. of the Army, COE, 2001). The USEPA, U.S. Amry Corps of Engineers (COE), and other interested parties are working to identify appropriate uses for dredged material rather than disposing of the material offshore. These uses may include beach nourishment or wetland habitat development.

A discussion of dredging operations in inland coastal regions around the Gulf is presented in **Chapter 4.1.3.3.3**.

4.1.3.2.2. Nonenergy Minerals Program in the Gulf of Mexico

The MMS's Marine Minerals Program provides policy direction for the development of marine mineral resources on the OCS. At present, the Program is focusing on collecting and analyzing geologic and environmental information developed through partnerships with 14 coastal States. The cooperatives identify OCS sand deposits suitable for beach nourishment and wetlands protection projects. Federal OCS sand and gravel resources must be wisely managed to ensure that environmental damage to the marine and coastal environments is minimized, mitigated, or does not occur. The MMS has focused on integrating the collected resource data provided through the State/Federal cooperative efforts with environmental information to not only identify suitable OCS sand deposits but also to provide needed environmental information to make decisions regarding the use of Federal sand for future beach nourishment activities.

Since 1992, MMS has spent over $11 million for marine mineral environmental studies. Site-specific, interdisciplinary studies have been conducted in identified sand borrow areas to provide basic information on the biological character of resident benthic communities, as well as the evaluation of potential dredging effects on the local wave and current regime.

This section discusses the impacts of the acquisition of nonenergy minerals (sand, shale, and gravel) from Federal waters in the WPA and CPA. There are many submerged shoals located on the OCS that are expected to be long-term sources of sand (sand borrow sites) for coastal erosion management. This sand is needed because of the general diminishing supply of onshore and nearshore sand. The renourishment cycles for beaches or coastal areas require quantities of sand that are not currently available from State sources. The offshore sites are an environmentally preferable resource because OCS sands generally lie beyond the local wave base and the influence of the nearshore physical regime where long-term dredging can result in adverse changes to the local wave climate and the beach. In addition, the offshore sites could provide compatible sand for immediate/emergency repair of beach and coastal damage from severe coastal storms. The economics of dredging in deeper waters is improving as dredging technology improves.

Sand resources must be managed on a long-term, system-wide basis in such a way as to ensure that environmental damage will not occur as a result of continual and prolonged use. Sand sources that are to be used on a continual, multiyear, multiuse basis may require biological/physical monitoring to ensure that long-term adverse impacts to the marine and coastal environment do not occur. An appropriate "condition of approval" or "stipulation" to support a lease for these areas might be the monitoring of the biological and physical regime during operations to ensure that no adverse impacts are or will occur. To date, proposed coastal erosion management projects have been examined on a case-by-case, project-specific basis.

Sand Resources Programs

The MMS's Marine Minerals Branch (MMB) has been developing and procuring contracts to provide needed environmental information regarding environmental management of OCS sand resources. The potential for exploitation of sand resources has grown rapidly in the last several years as similar resources in State waters are being depleted or polluted. Several OCS areas are being examined as possible sources of aggregate for construction purposes. Two sand leases were issued (and subsequently terminated) in the CPA (Holly Beach, Cameron Parish, Louisiana and South Pelto, offshore Terrebonne Parish, Louisiana) and none in the WPA.

In 2005, the MMB received a study entitled *Environmental Investigation of the Long-term Use of Ship Shoal Sand Resource for Large-Scale Beach and Coastal Restoration in Louisiana: Interim Report for Year 1* (Stone et al., 2005). The objectives of this study were to provide biological, physical, and other pertinent information that can be used by MMS analysts during the environmental evaluation of potential impacts associated with large-scale, cumulative extraction of sand from OCS blocks located on Ship Shoal, offshore Louisiana. This study is a Cooperative Agreement with Louisiana State University and co-funded with the Louisiana Department of Natural Resources. The information gathered during this study will likely be used should a decision be made to proceed with the preparation of an EA or an EIS in support of a negotiated agreement with the State of Louisiana for access to Federal sand resources. The information gathered during the course of this study will also enable MMS to monitor and assess the potential impacts of offshore dredging activities and to identify ways that dredging operations can be conducted so as to avoid or minimize long-term adverse impacts to the environment.

Another study, *Taxonomic Composition and Relative Frequency of the Benthic Fish Community Found on Natural Sand Banks and Shoals in the Northwestern Gulf of Mexico: A Synthesis of the Southeast Area Monitoring and Assessment Program's Groundfish Survey Database, 1982-2000* (Brooks et al., 2004), analyzed the Southeast Area Monitoring and Assessment Program (SEAMAP). The SEAMAP data was obtained from the Pascagoula NMFS office from the timeframe 1982-2000. Samplings surveys were extracted for four natural sand banks (Heald and Sabine Banks and Tiger and Trinity Shoals) and two control areas located in federally protected waters (**Figure 4-5**). Fish species listed as caught in the database were classified into one of four different habitat resource categories (pelagic, benthic, pelagic with benthic food, or temporary benthic) based upon published reports of Atlantic and GOM habitat use and patterns (Robins and Ray, 1986; McEachran and Fechhelm, 1998). Structured environments created by ridge and shoal features on the continental shelf have been found to provide a distinctive habitat when compared with homogeneous flat bottoms and are potential EFH. Sediment-based microhabitats are centered upon differences in sediment grain size, sorting, and chemistry. Benthic infauna and epibenthic invertebrate communities have been found to be influenced by the availability and spatial distribution of sediment types. Alteration of these microhabitats could have a direct impact upon the benthic invertebrate community and high level of trophic impacts also. The database was summarized to address (1) what commercial and noncommercial exploited species are found in these areas, (2) if a distinct fish community exploit these areas, (3) is taxonomic composition and relative frequency constant among all banks, and (4) is taxonomic composition and relative frequency constant between seasons (summer vs. winter). Deeper control areas with less variable salinity and oxygen levels appear to host a higher diversity and abundance of benthic fishes. Temporal and spatial patterns in the occurrence of benthic fishes on natural sand banks in the northern GOM are species-specific. A small number of commercially exploited species are found to utilize these habitats including several snapper species. No commercially exploited species is exclusive to these areas. There is a paucity of information on the actual sand banks and shoals themselves. The above area-specific studies and other sand-related studies can be found at http://www.mms.gov/sandandgravel/Louisianastudies.htm.

Another completed study, *Preliminary Infrastructure Stability Study, Offshore Louisiana* (Nairn et al., 2004) looked at the impacts associated with dredging sand near oil and gas infrastructure (primarily pipelines). Recommendations from this study are required on a provisional buffer to avoid direct or indirect impacts to pipelines. Buffer requirements for archaeological and hard-bottom resources and habitats were reviewed. Buffers are required and stipulated to avoid direct impacts with the dredge and avoid indirect impacts related to changes in seabed and the possibility of erosion or scour at the resource. The three buffer widths analyzed were 150 m (492 ft), which corresponds to the 500-ft buffer presented in the multisale EIS (USDOI, MMS, 2002a), 200 m (656 ft), which corresponds to the suggested 639-ft buffer presented by the MMS GOMR in a recent dredge test lease issued by the MMS within South Pelto Block 13, and 300 m, which is the upper end suggested by dredging contractors and consistent with the Draft Stipulations for the Sandy Point Borrow Areas were applied to pipelines in the vicinity of the potential borrow sites of Ship Shoal and South Pelto Areas, offshore Louisiana. Seabed gradients have been calculated at a variety of positions representing steepest gradients and existing gradients perpendicular to proposed protective berm corridors along pipelines and range from 1:285 to 1:1,800. These slopes are flatter than the recommended assumption of 1:100 to develop a buffer for a 3-m excavation or 1:300 for a 1-m excavation. Generally speaking, underwater stable slopes are around 1:3 immediately following dredging. The ultimate slope will depend upon many influencing factors such as sediment size, sediment transport, wave climate, etc. The proposed 300-m buffer width is more than sufficient to prevent indirect impacts related to subsequent seabed changes and a dredging depth should be limited to 1 m at this time. These recommendations have been based on limited investigation and are preliminary in nature. However, it is noted that, in the event the slopes evolve more quickly than expected towards the pipeline, mitigation measures are possible and could consist of filling in the pits.

Another study, entitled *Ship Shoal as a Prospective Borrow Site of Barrier Island Restoration, Coastal South-Central Louisiana, USA: Numerical Wave Modeling and Field Measurements of Hydrodynamics and Sediment Transport*, evaluated the potential response of mining Ship Shoal (**Figure 4-6**) on the wave field (Stone et al., 2004). During severe and strong storms, waves break seaward of the western flank of Ship Shoal. Therefore, removal of Ship Shoal (approximately 1.1 billion m^3) causes a maximum increase of significant wave height by 90-100 percent and 40-50 percent over the shoal and directly adjacent to the lee of the complex for two strong storm scenarios. Waves did not break over the shoal during weak storms and fair weather conditions. Within the context of increasing nearshore wave energy levels, removal of the shoal is not significant enough to cause increased erosion along the Isles Dernieres. Wave approach direction exerts significant control on the wave climate leeward of Ship Shoal for stronger storms, but not weak storms or fair weather. Instrumentation deployed at the shoal allowed comparison of measured wave heights with numerically derived wave heights using STWAVE. Correlation coefficients are high in virtually all comparisons, indicating the capability of the model to simulate wave behavior satisfactorily at the shoal.

The MMS funded another study entitled *Physical and Biological Effects of Sand Mining Offshore Alabama, U.S.A.* (Byrnes et al., 2004), where the physical processes and biological data were collected and analyzed at five sand resource areas offshore Alabama (**Figure 4-7**) to address environmental concerns raised by the potential sand dredging for beach replenishment. Nearshore wave and sediment transport patterns were modeled for existing and post-dredging conditions, with borrow site sand volumes ranging from 1.7 to 8.4×10^6 m³. Wave transformation modeling indicated that minor changes will occur to wave fields under typical seasonal conditions and sand extraction scenarios. Localized seafloor changes at borrow sites are expected to result in negligible impacts to the prevailing wave climate at the coast. For all potential sand excavation alternatives at borrow sites offshore Alabama, maximum variation in annual littoral transport between existing conditions and post-dredging configurations was approximately 8-1 percent. In general, increases or decreases in longshore transport rates associated with sand mining at each resource area amounted to about 1-2 percent of the littoral drift, distributed over an approximate 6-mi (10-km) stretch of shoreline. Because borrow site geometries and excavation depths are similar to natural ridge and swale topographic characteristics on the Alabama OCS, infilling rates and sediment types are expected to reflect natural variations within sand resource areas.

Impacts to the benthic community are expected from physical removal of sediments and infauna. Based on previous studies, levels of infaunal abundance and diversity may recover within 1-3 years, but recovery of species composition may take longer. Western areas can be expected to recover more quickly than eastern areas because of opportunistic life history characteristics of numerically dominant infauna west of Mobile Bay. Additional sand studies published in the *Journal of Coastal Research* can be found at http://www.mms.gov/sandandgravel/JCRVolume20MMSstudies.htm.

Several generic studies have been completed (in addition to the above mentioned site-specific studies) that would address environmental concerns, add to the knowledge base, and aid in the issuance of a sand lease. Recognizing that the environmental effects of dredging operations in many instances are similar for all areas, generic-type studies have also been initiated to examine the effects of particular types of dredging operations on various aspects of the physical, chemical, and biological environments, and to develop or recommend appropriate mitigation, laboratory modeling, or monitoring techniques to alleviate or prevent adverse environmental impacts.

- *Model Development or Modification for Analysis or Benthic and Surface Plume Generation and Extent during Offshore Dredging Operations*;
- *Worldwide Analysis of Shipwreck Damage Caused by Offshore Dredging: Recommendations for Pre-Operational Surveys and Mitigation to Avoid Adverse Impacts*; and
- *Review of Existing and Emerging Environmentally Friendly Offshore Dredging Technologies.*

Several ongoing studies between MMS and the Louisiana State University Coastal Marine Institute that would be used to address site-specific and/or regional environmental issues or concerns include:

- *Wave-Bottom Interaction and Bottom Boundary Layer Dynamics in Evaluating Sand Mining at Sabine Bank for Coastal Restoration, Southwest Louisiana;*
- *Ship Shoal, Louisiana: Sand , Shrimp, and Seatrout Investigation; and*

- *New WAVCIS Ocean Observing System on Ship Shoal, Louisiana*.

The studies' information is and will be used by MMS analysts to evaluate the effects of specific proposed dredging operations, as required under current environmental laws and legislation. The results are also incorporated, as appropriate, in lease requirements and stipulations for the dredging of OCS sand.

Additionally, MMS identified several OCS blocks offshore Louisiana where dredging activities could occur in the future. The USEPA, Region 6 and the Louisiana Department of Natural Resources considered using sand from the Ship Shoal area for a coastal barrier island protection project. The USCOE released a draft plan that identified Ship, Tiger, and Trinity Shoals as possible sand sources for coastal restoration projects. The following listing of OCS blocks offshore Louisiana have been identified were potential dredging activities could occur and will be included and/or updated in MMS's *Final Notice of Sale Package*: Ship Shoal Blocks 87-89, 94, and 95; South Pelto Area Blocks 12-14, 18, and 19; West Delta Area Blocks 27 and 49; Eugene Island Area Blocks 10, 18-35, 37-69, and 71-93; and South Marsh Island, North Addition Area Blocks 207-222, 226-232, and 241-246.

Dredging of sand in these Ship Shoal, South Pelto, West Delta, and South Marsh blocks and the associated presence of an ocean-going dredge vessel could present some use conflicts should the blocks be leased for oil and/or gas extraction. If this situation should arise, MMS will coordinate all activities of the dredge vessel(s) with any pertinent oil and gas lessees operating within the same area so as to preclude any adverse time and space-use conflicts.

4.1.3.2.3. Marine Transportation

An extensive maritime industry exists in the northern Gulf of Mexico. **Figure 3-17** showed the major ports and domestic waterways in the analysis area, while **Table 3-36** presents the 2004 channel depth, number of trips, and freight traffic of OCS-related waterways. Marine transportation within the analysis area should grow linearly based on historical freight traffic statistics given current conditions. Should any infrastructure changes occur, then the marine transportation would reflect these changes. For example, if a port in the analysis area (or outside the analysis area) deepened its channel or constructed new railroads or highways into the port area, then the number of trips and the volume of commodities into and out of the port would change accordingly. Or if a refinery near one of the ports were to close, then tanker traffic to that port may decrease.

Tanker imports and exports of crude and petroleum products into the GOM are projected to increase (USDOE, EIA, 2001). In 2000, approximately 2.08 BBO of crude oil (38% of U.S. total) and 1.09 BBO of petroleum products (13% of U.S. total) moved through analysis area ports. By 2020, these volumes are projected to grow to 2.79 BBO of crude oil and 1.77 BBO of petroleum products. Crude oil will continue to be tankered into the GOM for refining from Alaska, California, and the Atlantic.

Proposed Action Scenario: Marine transportation is not expected to change as a result of a WPA or CPA proposed action.

OCS Program Scenario: The number of trips and volume of commodities into and out of analysis area ports are expected to grow linearly based on historical freight traffic statistics. OCS Program activities over the 2007-2046 timeframe are not expected to change marine transportation.

4.1.3.2.4. Military Activities

The air space over the Western and Central GOM is used extensively by the Department of Defense (DOD) for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf (**Figure 2-2**). These warning and water test areas are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years. Based on that past experience, the following military stipulations are planned for leases issued within identified military areas.

Naval Mine Warfare Command Operational Area D contains 17 blocks in the WPA and is used by the Navy for mine warfare testing and training (**Figure 2-1**). The proposed Naval Mine Warfare Area Stipulation (**Chapter 2.3.1.3.3**) would apply to those blocks, if leased.

In addition to Naval Mine Warfare Command Operational Area D, the WPA has four warning areas that are used for military operations. The areas total approximately 21.3 million ac or 75 percent of the total acreage of the WPA. To eliminate potential impacts from multiple-use conflicts on the aforementioned area and on blocks that the U.S. Dept. of the Navy has identified as needed for testing equipment and for training mine warfare personnel.

A standard "Military Areas" stipulation is routinely applied to all GOM leases in the WPA and CPA. That stipulation includes the following provisions:

- *Hold and Save Harmless*: Lessee assumes all risks of damage or injury to persons or property in connection with activity performed by the lessee.
- *Electromagnetic Emissions*: Lessee agrees to control its own electromagnetic emissions and must coordinate with appropriate military installation command headquarters.
- *Operational*: Lessee must enter into an agreement with the appropriate military command headquarters prior to commencing any activities in designated warning and water test areas).

In addition, for many years, the MMS GOMR has reminded lessees and designated operators of their obligation to enter into this agreement and provided the address and telephone number of the appropriate military command headquarters each time an Exploration Plan (EP), Development Operations Coordination Document (DOCD), or lease-term pipeline application was approved for activities on OCS leases that contained the stipulation. Effective January 27, 2004, the MMS GOMR no longer provided these lease stipulation reminders in each individual EP, DOCD, or lease-term pipeline approval letter. Instead, NTL 2004-G02, "Military Warning and Water Test Areas," was issued to serve that purpose.

The CPA has seven designated military warning areas and two Eglin Water Test Areas (EWTA) that are used for military operations. These areas total approximately 16.8 million ac (about 29% of the total acreage of the CPA). Of the 16.8 million ac, 13.3 million ac (or 23% of the total acreage of the CPA) are covered by military warning areas in the CPA sale area. The EWTA totals approximately 7 million ac (about 12% of the total acreage of the CPA). In the CPA, the EWTA totals 3.7 million ac (or 6.3% of the total acreage of the CPA). In addition to the previously-noted standard "Military Areas" stipulation, the EWTA will require the following special stipulations:

- *Evacuation Stipulation*: Lessee is required to evacuate, upon receipt of a directive from the MMS Regional Director, all personnel from structures on the lease. Lessee must also shut-in and secure all wells and other equipment, including pipelines, on the lease.
- *Coordination Stipulation*: Lessee is required to consult with the appropriate military command headquarters regarding the location, density, and the planned periods of operation of surface structures on the lease, and to maximize exploration while minimizing conflicts with DOD activities prior to approval of an exploration plan by the MMS Regional Director.

Finally, given that all of the available CPA acreage identified for leasing consideration within this multisale EIS is west of the critical military mission zone of Eglin Air Force Base (i.e., a zone to the west of 86˚41' W. longitude), no additional stipulations to those previously identified for EWTA blocks will be needed (**Figure 2-2**).

4.1.3.2.5. Artificial Reefs and Rigs-to-Reefs Development

Artificial reefs have been used along the coastline of the U.S. since the early 19^{th} century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish, but in some instances also enhance the production of fish.

All OCS platforms have the potential to serve as artificial reefs. Offshore oil and gas platforms began providing artificial reef substrate in the GOM with the first platform installation in 1942. At present, there are nearly 4,000 platforms operating on the Gulf OCS. Of these platforms, 86 percent are in the CPA and 14 percent are in the WPA. The number changes as platforms are installed and removed on a regular basis. **Figure A-5** shows the distribution of oil and gas platforms across the GOM. These platforms comprise a large percentage of hard substrate in the Gulf. Consequently, this hard substrate has created the most extensive *de facto* artificial reef system in the world (Dauterive, 2000; Reggio, 1987; Stanley, 1994).

Historically, approximately 9 percent of the platforms decommissioned in the Gulf OCS have become used in the Rigs-to-Reefs (RTR) program. The rate of RTR development anticipated for the OCS Program for the years 2007-2046 is expected to increase and to exceed the rate of RTR's that have resulted since the initial artificial reef and RTR projects in 1979 and 1982, respectively. This projection is based on the fact that the number of platform removals (699) during the 5-year period 2001-2005 has exceeded the number of platforms installed (593) during the same period (**Appendix A.5**). This platform removal rate is projected to continue through the years 2007-2046. The exact number and percentage of the 5,997-6,097 platforms (**Table 4-4**) projected to be removed that will be available for RTR will be dependent on the location and water depth of the platforms.

In addition to the 2001-2005 platform removals presented in the previous paragraph, Hurricanes Katrina and Rita destroyed 113 platforms. This is the same number of platforms that were removed in 2005. Many of the destroyed platforms have the potential of being accepted into the RTR program.

Proposed Action Scenario: The number of platforms projected for a proposed action in the WPA is 28-41 (**Table 4-2**), and for a proposed action in the CPA it is 28-39 (**Table 4-3**). The number of RTR's anticipated as a result of a proposed action in the WPA is 3-4, and in the CPA it is 3-4 (approximately 10% of the number of platforms decommissioned and removed). This number could vary, however, depending on where and in what water depth the platforms are installed.

OCS Program Scenario: For the OCS Program for the years 2007-2046, a total of 2,958-3,262 platforms are projected to be installed and 5,997-6,097 platforms are projected to be removed. This number includes platforms projected to be installed and removed in the WPA and CPA during this 40-year period from past and future lease sales as well as from the proposed actions (**Tables 4-2 through 4-6**). If approximately 10 percent of these decommissioned platforms were to be used for RTR's, there may be as many as 600 additional RTR's Gulfwide.

4.1.3.2.6. Offshore Liquefied Natural Gas Projects

Chapter 4.1.1.8.6, Alternative Transportation Methods of Natural Gas, discusses LNG. In late 2002, the Deepwater Ports Act of 1974 (DWPA) was amended to include the establishment of natural gas ports on the OCS (the Maritime Transportation Security Act of 2002, Public Law 107-295, November 2002). The Act's amended provisions transferred the regulatory oversight of offshore natural gas terminals from the Federal Energy Regulatory Commission (FERC) to the Department of Transportation (DOT). The USCG, which moved from DOT to the Department of Homeland Security in 2003, retained its operational responsibilities for deepwater ports.

In June 2003, the Secretary of Transportation delegated the authority to license deepwater ports to the MARAD Administrator. The license application process is administered jointly between MARAD and the USCG, with MARAD primarily responsible for administrative matters and project financial reviews and the USCG primarily responsible for project engineering, operations, safety, and environmental reviews, which include compliance with NEPA. The license review process, including a decision on the license application, must be completed within 356 days of the filing of an application.

Renewed interest in LNG importation has resulted in more than 20 new import facilities proposals (onshore and offshore) that are currently before regulatory authorities. The following offshore projects are either proposed for or licensed in the GOM (**Table 4-10**).

Gulf Gateway is located approximately 116 mi offshore Louisiana and consists of a submerged turret loading system. On March 20, 2005, Gulf Gateway successfully commenced operations. The initial cargo delivery was made to the port by the world's first LNG regasification vessel, the *EBRV Excelsior*.

Gulf Landing will be located about 38 mi offshore Louisiana and will consist of a gravity-based structure (GBS) using open rack vaporizer (ORV) technology to re-gasify the LNG. The port will include a berth for mooring LNG carriers, LNG storage and regasification facilities, and pipelines to connect with existing natural gas pipeline systems in the GOM. The port was licensed in June 2005.

Main Pass Energy Hub facility is located approximately 16 mi offshore Louisiana. Alabama, Louisiana, and Mississippi have been designated as adjacent coastal states for this application process.

The facility will be a mix of new and existing structures. The proposal also includes the development of salt caverns for the storage of regasified natural gas. Most of its proposed "take away" pipelines will interconnect with existing OCS pipelines for transportation to the shore. The final public hearings were held in March 2006 and the FEIS was published in March 2006. The Governor of Louisiana sent a letter to MARAD objecting to the project, citing concerns about fisheries impacts from the ORV system and the need for revenue sharing from activities at the port. The applicant has informed the USCG and MARAD that it will alter its application by proposing to use a closed-loop system (submerged combustion vaporization with selective catalytic reduction) instead of the preferred open-loop ORV system to regasify the LNG. This change will minimize potential impacts to the GOM fisheries. However, a portion of the regasified natural gas will be consumed to provide the heat for the vaporization process (direct burning of about 1-1.5%).

Beacon Port will be located approximately 29 mi offshore Louisiana. The proposed main terminal would include two concrete GBS's for the port and it will use ORV technology for regasification. The proposed port transportation scheme will use existing OCS pipelines for transshipment of its natural gas output. The DEIS was published and the final public hearings were held in March 2006.

Bienville Offshore Energy Terminal will be located approximately 63 mi offshore Alabama. The proposed facility will utilize HiLoad technology and a SALM for offloading, and will use ORV technology on the HiLoads for regasifying the LNG offshore. The DEIS is being prepared.

More detailed information about each project can be obtained from the MARAD Internet website (http://www.marad.dot.gov/dwp/deepwater_ports/index.aspwww.dms.dot.gov) or from the USDOT Internet website (http://www.dot.gov). Use the USDOT Docket Number provided in **Table 4-10** to go directly to the docket or you may use the project name in a "simple search" to locate information on a specific port.

The proposed LNG ports are not without some controversy. The ORV regasification technology slated for use by nearly all of the currently proposed or licensed deepwater ports in the GOM resulted in concerns associated with impingement and entrainment of ichthyoplankton. The USCG, working with NOAA and USEPA, formulated monitoring requirements that were included in the February 16, 2005, Record of Decision for the Gulf Landing LNG port. Subsequent GOM LNG port applications are required to follow similar monitoring requirements. Under these provisions, a licensee will be required to monitor the intake and discharge of seawater at its LNG port. These requirements include the collection of baseline data as well as sampling during the operation of the port facilities. Based on the evaluation of these data, the use of adaptive technology and management practices may be required to mitigate a port's effects on the Gulf.

Most of the new U.S. LNG capacity is projected for the GOM area because of the locale's many operational advantages. There is spare capacity in the existing pipeline infrastructure to move the regasified natural gas to market, and deepwater ports can serve onshore facilities including intrastate as well as interstate pipelines. The "new" Gulf Coast terminals are projected to account for more than 70 percent of the imports into the U.S. in 2025 (USDOE, EIA, 2005h).

According to the Maritime Transportation Act of 2002 (MTSA), all LNG tankers entering U.S. waters must have certified security plans. These plans must be updated at least every five years and be re-approved whenever a change is made to a tanker that could affect the vessels security. Additionally, the MTSA specifies that all U.S. port facilities deemed at risk for a "transportation security incident," must prepare and implement security plans for deterring such incidents to the "maximum extent practicable. New marine anti-terrorist regulations became effective on July 1, 2004. The International Ship and Port Facility Security Code (ISPS Code) is a comprehensive set of measures to enhance the security of ships and port facilities, developed in response to the perceived threats to ships and port facilities in the wake of the September 11th attacks in the U.S. (USDOE, EIA, 2004b).

For security and safety reasons, there are several zones proposed around each of the potential terminals. The first is a 500-m (1,640-ft) safety zone that may be established and enforced by the USCG. This zone would exclude all unauthorized vessels from entering the designated area at any time. The second zone is a "precautionary area" of varying dimensions [from 2 km (1.2 mi) to 3.2 km (2 mi) or larger] that is proposed for all terminals. This zone advises mariners that a LNG carrier and/or support vessels may be operating in the area. There are no regulatory restrictions associated with this precautionary area. The purpose of this zone is to minimize the potential for collisions or other impacts with LNG carriers and support vessels by other marine traffic in the vicinity of the terminal.

4.1.3.3. Other Major Influencing Factors on Coastal Environments

4.1.3.3.1. Submergence of Wetlands

Other major factors contributing to submergence of wetlands along the Gulf Coast are eustatic sea-level rise and land subsidence. Eustatic sea-level rise is caused by the reduction of the volume of water stored in the polar ice caps and expansion of ocean waters because of global warming. Land subsidence is caused by a variety of localized natural and manmade events such as down-warping or horizontal movement of the earth's crust; weighted surface compression; oxidation, consolidation, settling, and dewatering of surface sediments; and depressurization of subsurface reservoirs during oil and gas production (Swanson and Thurlow, 1973; Morton, 2003; Morton et al., 2002). In localized areas, subsidence and sea-level rise can be offset by sedimentation, placement of dredged material, and peat formation.

During the past century, the rate of eustatic sea-level rise along the Louisiana coast was relatively constant at 2.3 mm/yr (0.9 in/yr, 23 cm/century), although the rate has varied from a sea-level decrease of 3 mm/yr (0.12 in/yr) to a maximum increase of 10 mm/yr (0.39 in/yr) over decade-long periods (Turner and Cahoon, 1988; Williams and Burkett, 2002). Submergence in the Gulf is occurring most rapidly along the Louisiana coast and more slowly in other coastal states. Depending on local geologic conditions, the subsidence rate varies across coastal Louisiana from 3 to over 10 mm/yr (0.12 to over 0.39 in/yr). One of the major factors causing greater submergence rates in Louisiana is reduced sedimentation, resulting from deltaic abandonment, flood control, and channelization of the Mississippi River. There is scientific consensus that sea-level rise will continue and is likely to increase into the next century. Based on the 2001 Intergovernmental Panel on Climate Change report, the best mid-range estimate is for a sea-level rise of approximately 50 cm (20 in) over the next century.

Subsidence or sinking of the land surface in southern Louisiana and the entire south-central U.S. is mainly attributed to the weight of Mississippi River mud that makes up the geography of the region, drainage and oxidation of organic soils, natural compaction and dewatering of surficial sediments, and tectonic activity (geosynclinal downwarping and movement along growth faults). The problem is aggravated in Louisiana by flood protection measures and disruption of natural drainage ways that reduce sediment deposition to the Deltaic region. Fluid withdrawal, including groundwater withdrawals and oil and gas production, can cause localized subsidence in the aquifer system and above the producing reservoirs. In coastal Louisiana, about 400 km^2 (98,842 ac) of wetlands have a subsidence potential greater than 10 cm (4 in) because of fluid withdrawal (Turner and Cahoon, 1988). Morton (2002) used geodetic releveling surveys to identify historical subsidence rates of 9.4 mm/yr and averaging 6.4 mm/yr along Bayou Petit Caillou in Terrebonne Parish, Louisiana. The average subsidence rate for Terrebonne Parish over the last 5,000 years is calculated at <3 mm/year (0.12 in/yr) (Roberts et al., 1994). Thus, hydrocarbon production can induce local subsidence rates sufficient to result in significant landloss.

4.1.3.3.2. River Development and Flood Control Projects

In recent decades, alterations in the upstream hydrology of the rivers draining into the northern GOM have resulted in a variety of coastal impacts. Dams and reservoirs on upstream tributaries trap much of the sediment load in the rivers. The suspended sediment load of the Mississippi River has decreased nearly 60 percent since the 1950's, largely as a result of dam and reservoir construction upstream (Tuttle and Combe, 1981; Turner and Cahoon, 1988).

In a natural system, over-bank flooding introduces sediments into adjoining wetlands. Flood control on the Mississippi and other rivers has largely eliminated flood-borne sedimentation in the Gulf coastal wetlands, contributing to their deterioration.

Channelization of the Mississippi and other rivers in conjunction with flood control levees has also contributed to wetland loss and has interrupted wetland creation around the Gulf by preventing distribution of alluvial sediments across deltas and flood plains. Prior to channelization, the flow of rivers was distributed among several distributary channels that delivered sediment over a broad area during high river stages. Today, sediment from the Mississippi River is primarily discharged through the main channel directly to the deep waters of the continental slope. The only significant exception to this scenario is the diversion of approximately 30 percent of the Mississippi River flow to the Atchafalaya

River; this diversion does not capture 30 percent of the sediment flow, however, since most of the sediment is restricted to the deeper river channel.

4.1.3.3.3. Dredging

Dredging operations include sediment and gravel harvesting; pipeline installation; canal installation, maintenance, and modifications; harbor installation and maintenance; and stream channelization.

Numerous channels are maintained throughout the onshore cumulative activity area by Federal, State, county, commercial, and private interests. Proposals for new and maintenance dredging projects are reviewed by Federal, State, and county agencies as well as by private and commercial interests to identify and mitigate adverse impacts upon social, economic, and environmental resources.

Typically, the COE schedules surveys every two years on each navigation channel under its responsibility to determine the need for maintenance dredging. Maintenance dredging is then performed on an as needed basis. Dredging cycles vary broadly from channel to channel and from channel segment to channel segment. A cycle may be 1-6 years. The COE is charged with maintaining all larger navigation channels in the cumulative activity area. The COE dredges millions of m^3 of dredged material per year in the cumulative activity area. Some shallower port-access channels may be deepened over the next 10 years to accommodate deeper draft vessels. These vessels, which support deepwater OCS activities, may include those with drafts to about 7 m (23 ft).

Materials from maintenance dredging are primarily disposed of on existing dredged-material disposal banks and in dredged-material disposal areas. Additional dredged-material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by the COE and relevant State agencies prior to construction. Some dredged sediments are dispersed into offshore waters at established offshore disposal sites. Materials may also be used in a beneficial manner to restore and create habitat, beach nourishment projects, and industrial and commercial development.

When placing the material on a typical dredged material disposal site, the usual fluid nature of the mud and subsequent erosion causes widening of the site, which may bury adjacent wetlands, submerged vegetation, or non-vegetated water bottoms. Consequently, adjacent soil surfaces may be elevated, converting wetlands to uplands, fringes of shallow waterbodies to wetlands, and some non-vegetated water bottoms to shallower water bottoms or emergent areas that may become vegetated due to increased light at the new soil surface.

Dredged materials from channels are often contaminated with toxic heavy metals, organic chemicals, pesticides, oil and grease, and other pollutants originating from municipal, industrial, and vessel discharges and non-point sources, and thus can result in contamination of areas formerly isolated from major anthropogenic sources (USEPA, 1979). The vicinities around harbors and industrial sites are most noted for this problem. Hence, sediment discharges from dredging operations can be major point sources of pollution in coastal waters in and around the Gulf. In addition, inland and shallow offshore disposal can change the navigability and natural flow or circulation of waterbodies.

In 1989, USEPA estimated that more than 90 percent of the volume of material dumped in the oceans around the U.S. consisted of sediments dredged from U.S. harbors and channels (USEPA, 1989). As of February 1997, in response to the Marine Protection, Research, and Sanctuaries Act of 1972, USEPA had finalized the designation of eight dredged-material disposal sites in the cumulative activity area. Another four sites in the Gulf are considered interim sites for dredged-material disposal. These sites primarily facilitate the COE's bar-channel dredging program. Generally, each bar channel of navigation channels connecting the Gulf and inland regions has 1-3 disposal sites used for disposal of maintenance dredged material. These are usually located in State waters. Some designated sites have never been used.

Installation and maintenance of any navigation channel and many pipeline canals connecting two or more waterbodies changes the hydrodynamics in their vicinity. These changes are typically associated with saltwater intrusion, reduced freshwater retention, changed circulation patterns, changed flow velocities, and erosion. When these channels are permitted for construction through sensitive wetland habitats or when sites are permitted for dredged-material disposal, measures are required to mitigate unavoidable adverse environmental impacts. Structures constructed to mitigate adverse hydrodynamic impacts and accelerated erosion includes dams, weirs, bulkheads, rip-rap, shell/gravel mats, and gobi mats.

Typically, little or no maintenance is performed on mitigation structures. Without maintenance, many mitigation facilities, particularly in regions where the soil is poorly consolidated and has a high organic content, are known to become ineffective within a few years of construction. The number of mitigation structures associated with navigation and pipeline channels is unknown.

4.1.3.3.4. Coastal Restoration

The coastal infrastructure that supports State and OCS oil and gas activities would benefit from coastal restoration. Coastal erosion could have a significant negative impact on this coastal infrastructure, including pipelines, navigation channels, and supply bases (U.S. Dept. of the Army, COE, 2004c). The extensive pipelines traversing coastal Louisiana are affected by coastal erosion as barrier islands and coastal wetlands erode and as open water scours away land-protecting pipelines. Exposed pipelines, once buried, are at increased risk from failure or damage because of lack of structural stability, anchor dragging, and boat collisions. Navigation infrastructure is also already being impacted by coastal erosion as shown in three areas of the Gulf Intracoastal Waterway (GIWW). In those areas there is increased shoaling, causing traffic moving on the waterway to slow down, increasing the time and cost of moving commodities. Annual dredging maintenance cost has increased to keep the channel at authorized depths. Supply bases servicing offshore OCS oil and gas activities are also impacted by coastal erosion. These bases provide necessary supplies and maintenance services to the offshore platforms and serve as "jumping-off" points for employees that work on offshore platforms. If one of the important supply bases, such as Port Fourchon, was severely impacted by coastal degradation, the operational cost of offshore production could go up significantly.

State

The Louisiana DNR's Office of Coastal Restoration and Management is responsible for the maintenance and protection of the State's coastal wetlands, and the Coastal Restoration and Engineering Divisions are responsible for the construction of projects aimed at creating, protecting, and restoring the State's wetlands.

In Louisiana, from 1986 to 2005, 558 coastal restoration projects have been constructed from 1986 to 2005 (LADNR, 2006d). Of those, 41 were State-funded projects, 74 were Breaux Act projects, 37 were part of the Parish Coastal Wetlands Restoration Program (Christmas Tree Program), 35 were other federally assisted projects, and 371 were part of the Vegetation Planting Program. An additional 59 Breaux Act projects have been approved and are in the design phase.

The State of Texas General Land Office is responsible for the maintenance and protection of the State's coastal wetlands. Under the authority of the Coastal Erosion Planning and Response Act (CEPRA), the General Land Office collaborates with Federal and local governments and private citizens and groups to develop habitat protection, restoration, and renourishment programs and projects, and fund studies. The General Land Office leverages State-appropriated funds with Federal and private partner funding to accomplish its mission and goals.

Federal

In fiscal year 2001, the Coastal Impact Assistance Program (CIAP) was authorized by Congress to assist States in mitigating the impacts associated with OCS oil and gas production. Congress appropriated approximately $150 million to NOAA to be allocated to seven coastal states—Alabama, Alaska, California, Florida, Louisiana, Mississippi, and Texas. Under CIAP, NOAA administered more than 150 separate grants to States and localities. The CIAP funded more than 600 projects including habitat protection and restoration, land acquisition, and water quality improvement projects (USDOC, NOAA, 2006). Under the Energy Policy Act of 2005, Congress reauthorized CIAP, which is now administered by MMS (**Chapter 1.3**). Under Section 384 of the Energy Policy Act, MMS shall disburse $250 million for each fiscal year 2007 through 2010 to eligible producing States and coastal political subdivisions.

MMS Study

The MMS is a sponsor and participant in "The Economic and Market Impacts of Coastal Restoration: America's Wetland Economic Forum II" held in late September 2006. Part of this effort, lead by the L.S.U. Center for Energy Studies, will examine the local, regional, and national infrastructure at risk in the Gulf region, with a particular focus on energy infrastructure. This project will be examining the potential positive impacts that coastal restoration would play in protecting and maintaining energy infrastructure. The study will use GIS tools to simulate coastal erosion and flooding scenarios to identify potential "at risk" energy infrastructure assets along the Gulf Coast, including Louisiana. The recent flooding experiences from Hurricanes Katrina and Rita will be used in case studies to examine recent infrastructure exposure to flooding. Certain scenarios on coastal erosion and flood relationships will be considered as well (i.e., hypotheticals on how coastal restoration could have impacted the degree of flooding, and in turn, the impact on infrastructure). Traditional economic analysis using valuation techniques will be considered, as well as other methods like economic impact approaches. The first phase of this project will be to recommend methods for estimating overall economic impacts of coastal restoration. A case study on one area of infrastructure in the State of Louisiana will be provided. The first phase of the project is anticipated to be completed and presented at the Economic Forum II in late September 2006. The second phase will codify the research into a final research report/paper that will be presented at the end of the year at the 3rd National Conference on Coastal and Estuarine Habitat Restoration, December 9-13, 2006 in New Orleans, Louisiana.

4.1.3.3.5. Alternative Energy

On August 8, 2005, President George W. Bush signed into law the Energy Policy Act of 2005 (the Act). Section 388 (a) of the Energy Policy Act of 2005 amended Section 8 of the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. 1337) to authorize the Department of the Interior (DOI) to grant leases, easements, or right-of-ways on the OCS for the development and support of energy resources other than oil and gas and to allow for alternate uses of existing structures on the OCS lands. The Act clarifies the Secretary's authority to allow the existing oil and gas structures on the OCS lands to remain in place after oil and gas activities have ceased and to extend the life of these facilities for non-oil and gas activities such as research, renewable energy production, aquaculture, etc., before being removed. The MMS is authorized to develop a comprehensive program and regulations to implement the new authority. As a part of this process, MMS has published an Advance Notice of Proposed Rulemaking (ANPR) in the *Federal Register* on December 30, 2005, and seeks comments on alternate energy-related uses on the OCS. The MMS published a Notice of Intent (NOI) to prepare a programmatic EIS on May 6, 2006.

Wind energy is one of the most popular sources of clean and renewable energy that has been in use for centuries and is the only alternate use of the OCS Federal lands to be discussed in this section. Wind farms are composed of tens of individual wind turbines in an area that produce electricity for commercial consumption. Today, wind energy is the fastest-growing renewable energy resource in the world. Worldwide total installed wind power capacity now stands at 59,322 megawatts (MW) and U.S. installed wind power capacity is 9,149 MW (Global Wind Energy Council, 2006). Offshore wind has emerged as a promising renewable energy resource for a number of reasons: (1) strong and consistent winds are in proximity to major load centers in the energy-constrained northeastern U.S.; (2) long-term potential for the over-the-horizon siting and undersea transmission lines counters the aesthetics and land-use concerns associated with onshore wind installations; and (3) as a fuel, wind is both cost-free and emission free (MTC et al., 2005).

At present, 10 offshore wind farms are in operation; all are located off the coast of Europe in waters generally shallower than 25 m (82 ft). Many other countries, including the U.S., are also expressing serious interest in developing this offshore resource (British Wind Energy Association, 2005). Two wind farm projects are currently going through the permitting process in the U.S. The Cape Wind project is located on Horseshoe Shoal in Nantucket Sound, Massachusetts, and consists of 30 turbines designed to generate up to 454 MW. The Long Island Power Authority project is located off the south shore of Long Island, New York. This project would consist of 40 turbines designed to generate 130 MW of energy for the Long Island, New York region. Initial applications for these projects were submitted before the passage of Energy Policy Act of 2005.

The wind resource potential of the Gulf of Mexico (GOM) is not very well documented. Archer and Jacobson (2003) conducted a study of U.S. winds and wind power at 80 m (256 ft) height. Their study concluded that the GOM has a higher potential of wind resources than previously thought. These unexpected levels of wind velocity have led to interest in wind energy generation in the GOM. On October 24, 2005, the Texas General Land Office (GLO) announced that the State of Texas has signed an agreement with Galveston-Offshore Wind, LLC, to allow the first offshore wind energy project on the GOM. Under the terms of this agreement the company will lease an 11,355-ac tract located about 7 mi off the coast of Galveston Island in Texas State waters. The company will also build and operate two 80-m (256-ft) meteorological towers to collect wind data in the GOM. Data gathered from these towers will help to evaluate the site's potential and to determine exact location of the wind farm. The company plans to build 50 turbines expected to produce 150 MW of electricity, enough to power about 40,000 homes (Texas General Land Office, 2005c). In May 2006, the GLO announced the State's second—and the Nation's largest—offshore wind farm, which will be built off the coast of Padre Island National Seashore. Houston-based Superior Renewable Energy will build and operate the wind farm, which will generate 500 megawatts of electricity—enough to power 125,000 homes. The project is expected to be running in 5 years.

Until the MMS promulgaes the regulations under which these projects will operate, MMS will accept no proposals for alternate energy development or for alternate uses of the existing oil and gas facilities located on the Federal OCS. Once MMS finalizes appropriate regulations, the demands for projects of this type are expected to grow on the OCS. Evaluation of meteorological data collected in Texas State waters would also tell us in the near future about the possibility of siting wind farms on the Gulf's OCS for generating electricity. .

4.1.3.4. Major Sources of Oil Inputs in the Gulf of Mexico

Petroleum hydrocarbons can enter the GOM from a wide variety of sources. These sources include both natural geochemical processes and the onshore and offshore activities of man. Natural seeps are the predominant petroleum hydrocarbon source to offshore waters. The discharge of petroleum hydrocarbons in produced water is the largest oil input to the OCS that is the result of human activities. Land-based sources are the greatest source of hydrocarbons to coastal waters. Spills of hydrocarbons may occur in both offshore and coastal waters when crude oil is extracted as well as during transportation and consumption of petroleum products. Numerical estimates of the contribution of these sources to the GOM coastal and offshore waters are presented in **Tables 4-11 and 4-12**, respectively. In these tables, the GOM is divided into Western and Eastern so that the contribution from regional industrial activities or urban areas can be observed. These estimates include information presented in *Oil in the Sea III, Inputs, Fates, and Effects* (NRC, 2003), and incorporate new research and databases that have become available since the previous version of *Oil in the Sea* published in 1985.

Although the GOM comprises one of the world's most prolific offshore oil-producing provinces as well as having heavily traveled tanker routes, inputs of petroleum from onshore sources far outweigh the contribution from offshore activities. Man's use of petroleum hydrocarbons is generally concentrated in major municipal and industrial areas situated along coasts or large rivers that empty into coastal waters.

Tables 4-11 and 4-12 and the following paragraphs provide a description of these estimated oil input sources.

4.1.3.4.1. Natural Seepage

Natural seeps provide the largest petroleum input to the offshore GOM, about 95 percent of the total. Estimates have ranged from 28,000 bbl per year (4,000 tonnes) to 204,000 bbl (29,150 tonnes) of oil per year (McDonald, 1998; Wilson et al., 1973). Using commercial remote-sensing data, Mitchell et al. (1999) estimated a range of 280,000 bbl to 700,000 bbl per year (40,000 to 100,000 tonnes per year) with an average of 490,000 bbl (70,000 tonnes) for the northern GOM, excluding the Bay of Campeche. Using this estimate and assuming seep scales are proportional to surface area, the NRC (2003) estimated annual seepage for the entire GOM at about 980,000 bbl (140,000 tonnes) per year. As seepage is a natural occurrence, the rate is expected to remain the same throughout the 40-year analysis period (**Table 4-12**).

4.1.3.4.2. Produced Water

Small amounts of oil are routinely discharged in produced water during OCS operations. Produced water is treated and discharged overboard. The oil and grease content is limited by USEPA effluent limitation guidelines to a monthly average of 29 mg/l oil content (USEPA, 1993a and b). The NRC (2003) estimates the discharge of 4,130 bbl (590 tonnes) per year petroleum hydrocarbons to the coastal western GOM and 11,900 bbl (1,700 tonnes) to the offshore western GOM through produced-water discharges.

A typical annual amount of OCS-produced water to be discharged in the future was estimated based on annual historical quantities reported to MMS for the last 10 years (**Chapter 4.1.1.4.2**, Produced Waters). The average annual volume of 596 MMbbl per year of OCS-produced water would contribute 19,250 bbl (2,750 tonnes) of petroleum hydrocarbons to the GOM waters (**Tables 4-11 and 4-12**).

4.1.3.4.3. Land-based Discharges

Land-based sources provide the largest petroleum input to the coastal waters of both the western and eastern GOM. For coastal waters, 77,000 bbl (11,000 tonnes) of petroleum hydrocarbons enter the western GOM and 11,200 bbl (1,600 tonnes) enter the eastern GOM from land-based discharges. Land-based sources include residual petroleum hydrocarbons in municipal and industrial wastewater treatment facility discharges as well as urban run-off. The Mississippi River carries the majority of petroleum hydrocarbons into GOM waters from land-based drainage that occurs far upriver. With increased urbanization, particularly in coastal areas, the amount of impervious paved surface increases and oil contaminants deposited on these roads and parking lot surfaces are washed into adjacent streams and waterbodies.

The previous edition of *Oil in the Sea* (NRC, 1985) determined petroleum in urban runoff based on the human population. *Oil in the Sea* (NRC, 2003) utilized the USEPA's water quality data repository (STORET) when available, which measures ambient oil and grease in major rivers, and U.S. Bureau of Census data to generate a unit load of petroleum hydrocarbon per square mile of urban area (NRC, 1995). Oil and grease measurements include compounds that are not of petroleum origin so a conversion factor obtained from existing research was used to convert oil and grease measurements to petroleum hydrocarbons.

4.1.3.4.4. Spills

Oil spills occur during the production, transportation, and consumption of oil. This wide variety of sources includes spills from production wells and platforms during extraction; spills during transportation by tanker, barge and other vessels; spills from pipelines in both Federal and State waters; shore-based storage tanks and coastal facilities; mystery sources; and spills during refining and consumption. The composition of spilled hydrocarbons includes crude oil, refined fuels such as diesel during transport and storage and spills during consumption. The NRC (2003) estimates that 630 bbl (90 tonnes) of petroleum hydrocarbons are spilled from coastal western GOM and 350 bbl (50 tonnes) are spilled from offshore western GOM. Spills from pipelines in the coastal area of the western GOM contribute 6,230 bbl (890 tonnes) and are the largest amount of oil by source to that region. Spillage from tankers in the coastal area of the eastern GOM contribute 980 bbl (140 tonnes), the largest amount of oil by source to that region, but the data do not differentiate between foreign, State, or OCS oil. Spills of refined products from coastal pipelines and marine terminals are the main contributors to the coastal facility inputs to coastal waters. In offshore waters, spills from commercial vessels >100 gross tons (GT) contribute 490 bbl (70 tonnes) per year to the eastern OCS and are the largest amount of oil by source to that region. Tank vessel spills input 10,500 bbl (1,500 tonnes) per year to the western OCS. At the national level, tankers and tank barges were responsible for 82 percent of the total spillage. The type of oil spilled nationally was as follows: 36 percent crude oil; 36 percent heavy distillate (No. 6 fuel oil, bunker C); 25 percent light distillate (diesel, kerosene); and 3 percent gasoline.

4.1.3.4.4.1. Trends in Spill Volumes and Numbers

Databases on spills that have occurred in the GOM are not comprehensive. As almost 38 percent of all U.S. spills have occurred within the waters of the GOM and Gulf Coast States, the trends for all U.S. spills is assumed to be representative of trends in spills that have occurred in the northern GOM. The following is a summary of what is known about trends in U.S. spill risk and is derived from USCG data (USDOT, Coast Guard, 2001):

Volumes

- The volume of spill incidents in U.S. waters has been on a steady downward trend since 1973. There has been a general downward trend in the number of spills over 24 bbl (1,000 gallons).
- There have been no oil spills over 23,810 bbl (1 million gallons) since 1991. The total volume spilled in 2000 is at the lowest amount in over 25 years.
- The majority of spills since 1973 involved discharges between 0.024 and 2.4 bbl (1 and 100 gallons).
- The decline in oil-spill volume, particularly in the face of growing domestic demand for imported oil, represents the combined effects of an increasingly effective campaign of positive prevention and preparedness initiatives to protect U.S. coastal waters from oil pollution.

Number

- The total number of spill incidents remains relatively constant from year to year.

Location

- Most (75.1%) of all spills from 1973 to 2000 occurred within 3 nmi of shore.
- Most (83.8%) of the volume of all spills occurred in waters within 3 nmi of shore.

Sources

- Spills from tank vessels (ships/barges) account for the majority of volume spilled: 46.8 percent of the volume of oil spilled from 1973 to 2000 came from tank vessels; 22 percent from facilities and other non-vessels; 17.5 percent from pipelines; 7.7 percent from mystery spills; and 5.9 percent from non-tank vessels.
- 33 percent of the number of all spills from 1973 to 2000 occurred from non-tank vessels; 25 percent were "mystery" spills; 29 percent were from facilities and other non-vessels; 10 percent were from tank vessels (ships and barges carrying oil); and 3.5 percent were from pipelines.
- The rates for oil spills ≥1,000 bbl from OCS platforms, tankers, and barges continues to decline.

Types of Oil

- A combination of crude oil and heavy oil is the type of oil with the greatest volumes spilled (62%).
- Crude oil and heavy oil were the most frequent types of oil spilled (36% of the number of spills from 1973 to 2000 were the discharge of crude oil or heavy oil).

4.1.3.4.4.2. Spills as the Result of Hurricanes

This section discusses the causes and volumes of spills that resulted from Hurricanes Lili, Ivan, Katrina, and Rita. **Chapter 3.3.5.7.3**, Damage to Offshore Infrastructure from Recent Hurricanes, gives a summary of damage to the OCS-related platforms, rigs, and pipelines caused by Hurricanes Ivan, Katrina, and Rita.

As discussed in **Chapter 1.5**, MMS's regulations that govern oil and gas production safety systems require that production safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. Part of those safety systems are subsurface safety valves (SSSV's), which shut off well flow in the production tubing (100 ft (30 m) or more below the seafloor), in the event of emergencies, such as fire or production tubing separation. All wells on the OCS must be equipped with SSSV's. Should a platform be damaged, these valves "shut-in" production flow to prevent pollution events until the production can be safely reestablished. During Hurricanes Ivan, Katrina and Rita, these valves performed 100 percent successfully (U.S. Senate, Committee on Energy and Natural Resources, 2005; USDOI, MMS, 2005g).

Hurricane Lili (October 2002) damaged the wellhead of a well that had been shut-in awaiting MMS approval for plugging and abandonment operations. A mixture of oil, gas, and water was discharged over several days. Of the approximately 350 bbl of oil spilled, 205 bbl was not recovered (USDOI, MMS, 2003).

Hurricane Ivan (September 2004) caused mudslides in the vicinity of the mouth of the Mississippi River. Although platforms were shut-in as part of the hurricane evacuation procedures, pipelines that were severed by the mudslides released product present in the lines. Some pipelines were dragged 200-300 ft from their original position and others were buried in 20-30 ft of mud. On the OCS about 5,000 bbl of oil were spilled, and in State waters about 11,000 bbl was spilled. Tropical Storm Matthew (October 2004) further dispersed the unrecovered oil.

Hurricane Katrina (August 2005) resulted in considerable catastrophic onshore damage to storage tanks and pipelines along the Mississippi River onshore, including storage tanks that emptied into a residential area in Chalmette, Louisiana. Ten spills resulted in the release of 191,000 bbl onshore (Louisiana Sea Grant, 2005). On the OCS, Hurricane Katrina caused 70 spills of ≥1 bbl. None of these OCS spills reached the coastline. Of the 70 spills totaling 5,552 bbl that occurred from damage to pipelines and offshore facilities during and after Hurricane Katrina, 23 (33%) were of amounts ≥50 bbl. These 23 spills account for 5,047 bbl of petroleum products, 91 percent of the total spillage because of Hurricane Katrina. One spill included in that percentage was estimated at 2,000 bbl in Mississippi Canyon Block 109. This is the only spill of ≥1,000 bbl that occurred as a result of this storm. The 2,000-bbl estimate is the higher value of an approximated range for this particular spill, which may be on the order of only a few hundred barrels, as an investigation into the spill is ongoing. For OCS waters, Hurricane Katrina spill data was reviewed and compiled and is available on the MMS website at http://www.mms.gov/incidents/SigPoll2005.htm.

The storm surge from Hurricane Rita (September 2005) damaged booms and re-oriented oil spilled during Hurricane Katrina, but it did not result in additional major spills onshore (Louisiana Sea Grant, 2005). On the OCS, 54 pollution incidents that involved spills of ≥1 bbl that did not reach the shoreline were recorded. The 54 spills of ≥1 bbl totaled 12,100 bbl of petroleum. Seventeen of these spills, at ≥50 bbl each, accounted for 98 percent of the total spillage volume, or 11,800 bbl. Hurricane Rita resulted in five spills of ≥1000 bbl, which accounts for 8,429 bbl, or 70 percent, of the total spill volume because of this storm. The locations and spill estimates, respectively, for each of these five largest spills are as follows: Eugene Island Block 51, Eugene Island Block 95, Eugene Island Block 314, South Marsh Island Block 146, and Ship Shoal Block 250, reporting spills of 100-1,812 bbl; 100-1,551 bbl; 2,000 bbl; 1,494 bbl; and 1,572 bbl.

Spill amounts for Eugene Island Blocks 51 and 95 have been estimated to range from a value of at least 100 bbl, considered likely, to high value of 50 percent of a worst-case scenario spill for these locations. This worst-case scenario of 100 percent loss at 100 percent capacity is considered unlikely because the pipeline cracks were small, the pipelines were found to have retained sizeable volumes of condensate subsequent to the hurricane, and there were no sheen sightings reported despite overflight activity in and around the areas in question. These factors do not support the occurrence of a spill of large magnitude. For OCS waters, Hurricane Rita spill data is currently available on the MMS website at http://www.mms.gov/incidents/SigPoll2005.htm.

The USCG uses a spill classification system to categorize spill sizes. Under this system, a major spill is ≥2,381 bbl (100,000 gallons), a medium spill is between 238 and <2,381 bbl (10,000 and 100,000 gallons), and a minor spill is <238 bbl (10,000 gallons). Hurricanes Katrina and Rita, despite the amount of destruction they caused to offshore structures, caused no major oil spills. A total of 124 spills (of ≥1 bbl), totaling 17,652 bbl, were caused by these two hurricanes. There have been no reports of a negative impact to the coastline or to birds or mammals as a result of these materials spilled from Federal OCS facilities.

Hurricane Katrina caused 56 percent of the total number of spills but accounted for 31 percent of the total volume of spilled petroleum. Hurricane Rita, responsible for 44 percent of the total number of spills, caused a larger spill volume, accounting for 69 percent of the total number of barrels spilled. Of the 124 total spills, 40 were of amounts ≥50 bbl, and these account for 95 percent of the total number of barrels spilled. The six largest spills, estimated at ≥1,000 bbl, that occurred as a result of these two storms and were previously mentioned individually, represent only 5 percent of the total number of spills but represent 59 percent of the total volume of spilled petroleum. The estimated spill amounts for Hurricanes Katrina and Rita and their combined totals are presented in the tables below.

Spill Estimates for Hurricanes Katrina and Rita (in bbl) for Spills ≥1 bbl

Hurricane	Crude and Condensate	Diesel and Refined Petroleum	Total Spillage	Number of Spills
Katrina	4,962	590	5,552	70
Rita	8,175	3,925	12,100	54
Total	13,137	4,515	17,652	124

Spill Estimates for Hurricanes Katrina and Rita (in bbl) for Spills ≥50 bbl

Hurricane	Crude and Condensate	Diesel and Refined Petroleum	Total Spillage	Number of Spills
Katrina	4,468	579	5,047	23
Rita	8,038	3,762	11,800	17
Total	12,506	4,341	16,847	40

Note: Amounts have been estimated to the nearest barrel.

The impacts of hurricanes on water quality include sediment resuspension and re-release of any contaminants present, increased mixing within the water column, oil and chemical spills, and the introduction of nutrients and chemical and biological contaminants transported via onshore flooding. Studies of the impacts to coastal waters by USEPA and NOAA have shown that degradation is temporary, and recovery will occur within weeks for pathogenic contaminants to months for oil spills that require cleanup. Pollutant levels were below USEPA National Ambient Water Quality Criteria and NOAA effects levels for sediments. In some cases, such as destroyed platforms or pipelines, the oil remains sequestered until the time when the structure is decommissioned, at which time the oil can be recovered.

4.1.3.4.4.3. Projections of Future Spill Events

Table 4-13 provides the estimated number of all spill events that the MMS projects will occur within coastal and offshore waters of the GOM area for a representative future year (around 15 years after the proposed action). **Table 4-13** includes spills due to both OCS and non-OCS activities, in two size categories (≥1,000 bbl and <1,000 bbl), and in coastal or offshore waters. The number of offshore OCS spills ≥1,000 bbl was determined using 40-year program resource projections and spill rates (**Table 4-15**), while the number of offshore non-OCS spills and coastal OCS and non-OCS spills <1,000 bbl was determined from historical counts. No annual average for all spills is appropriate because the timeframes and peak years vary for the different types of activities that could spill oil. More detailed coverage of projected OCS oil-spill probability of occurrence and transport is presented in **Chapter 4.3.**

The projections of future spill occurrences shown in **Table 4-13** were formulated using the following sources: an MMS analysis of the USCG database on spill incidents in all navigable waters (USDOT, Coast Guard, 2001); USCG data provided to MMS on all GOM oil spills from 1985 to 2001; and an analysis of crude oil and petroleum product spills ≥1,000 bbl from OCS operations, and tanker and barge operations (Anderson and LaBelle, 2000).

4.1.3.4.4.4. OCS-Related Offshore Oil Spills

Spills could happen because of an accident associated with future OCS operations. Spills estimated to occur as a result of a proposed action (**Chapter 4.3.1**) are a subset of all potential OCS spills; therefore, the discussion and information found in **Chapter 4.3.1.4** on MMS estimates of future spill sizes, characteristics, and fate is incorporated here by reference.

Probability of OCS Offshore Spills ≥ 1,000 bbl Occurring: The probabilities of one or more offshore spills ≥1,000 bbl occurring from future OCS operations are provided in **Table 4-15**. The last column in the table provides the chance of one or more spills occurring for Gulfwide OCS operations. For the Gulfwide OCS Program, there is a greater than 99 percent chance that there will be an offshore spill ≥1,000 bbl occurring in the next 40 years.

Probability of OCS Offshore Spills ≥ 10,000 bbl Occurring: The probabilities of one or more offshore spills ≥10,000 bbl occurring from future OCS operations are provided in **Table 4-15**. The last column in the table provides the chance of one or more spills occurring and for Gulfwide OCS operations. For the Gulfwide OCS Program, there is greater than a 99 percent chance that one or more spills ≥10,000 bbl will occur in the next 40 years.

Mean Number of OCS Offshore Spills (OCS Program): Based on an analysis of spill rates and projected sources, and using the low and high resource estimates, MMS projected the mean number of offshore oil-spill events estimated to occur and the likelihood that these events will occur from OCS Program activities. **Table 4-15** provides the mean number of offshore spills ≥1,000 bbl and ≥10,000 bbl estimated by source and for each planning area, as well as the Gulfwide OCS Program.

The estimated number of possible spills ≥1,000 bbl that could occur shows a widespread frequency distribution. **Figures 4-8, 4-9, and 4-10** show that there is a great deal of uncertainty as to the number of future OCS spills that will occur. If the low resource estimate is realized, about 39 possible spills ≥1,000 bbl that could occur. For the high resource estimate, about 49 possible spills ≥1,000 bbl could occur. The mean number of spills that could occur was estimated by the MMS for different size categories for the Gulfwide OCS Program. The mean number of spills >10,000 bbl for the Gulfwide OCS Program is estimated to be between 11 and 13 spills. The following table provides MMS's estimate of the mean number of spills to occur in each size grouping.

Estimated Number of Offshore Spill Events (mean)
by Size Category for Different OCS Oil Development Scenarios

Size Category	OCS Program—Gulfwide
≤1 bbl	95,900-109,350
>1 and <10 bbl	2,150-2,450
≥10 and <50 bbl	450-500
≥50 bbl and <500 bbl	180-205
>500 and <1,000 bbl	15-17
≥1,000 bbl	43-49

Sources of OCS Offshore Spills: **Table 4-15** distinguishes spill occurrence risk by likely operation or source. Besides spills occurring from facilities and during pipeline transport, as was the only case for a proposed action, offshore spills could occur due to OCS future operations from an FPSO or from shuttle tankers transporting OCS crude oil into ports. **Table 4-15** includes the likelihood of a spill from a shuttle tanker accident carrying OCS produced crude oil. The scenario with the highest risk of spill occurrence is the high-case resource estimate for the OCS Program in the CPA, which assumes some shuttle-tanker transport of OCS-produced oil. Under that scenario, there is a 63 percent chance that a spill ≥1,000 bbl and a 29 percent chance that a spill ≥10,000 bbl would occur from an OCS-related shuttle tanker during the 40-year analysis period.

Estimated Spill Size: **Table 4-13** shows the estimated spill sizes for OCS spills. Offshore spill sizes were estimated based on historical records for a representative future year (Anderson and LaBelle, 2000).

Annual Numbers: **Table 4-13** shows the estimated number of OCS spills yearly rather than for the 40-year program. One offshore OCS-related spill of ≥1,000 bbl due to a pipeline release is anticipated. Offshore OCS Program spills <1,000 bbl were estimated based on historical records collected from 1985 to 2001 and about 450-500 spills <1,000 bbl occurred from OCS offshore sources yearly. Less documentation is available for spills <1,000 bbl because they are more routine, they do not persist on the water as long, and they are likely to pose less of an environmental threat than larger spills. Additionally, many of the reported spills are of an unknown origin.

4.1.3.4.4.5. Non-OCS-Related Offshore Spills

Most offshore non-OCS spills occur from vessel and barge operations. Transit spills occur from navigation-related accidents such as collisions and groundings. Intrinsic spills are those occurring from accidents associated with the vessel itself, such as leaks from hull cracks, broken seals, and bilge upsets. Transfer spills occur during cargo transfer from accidents such as hose ruptures, overflows, and equipment failures.

Collisions and groundings have occurred very infrequently, less than one per 1,000 trips (USDOT, Coast Guard, 1993) and do not usually result in an oil spill. However, these accidents have resulted in the largest spills. The frequency of vessel collisions, and thus associated spills, increases as the proximity to shore increases because of the often-congested waterways in the Gulf region.

Most small non-OCS offshore spills occur during the cargo transfer of fuel and crude oil. Lightering of oil (the transfer of crude oil from supertankers to smaller shuttle tankers) is a common occurrence in the GOM. There have been about 3-4 spills per 1,000 lightering transfers, with an average spill size of 3 bbl (USDOT, Coast Guard, 1993).

Table 4-13 provides the MMS's projections of spills that could occur offshore from non-OCS sources for a typical future year. It is assumed that all offshore spills ≥1,000 not related to OCS operations will occur from the extensive maritime barging and tankering operations that occur in offshore waters of the GOM. The analysis of spills from tankers and barges ≥1,000 bbl is based on data obtained from the USCG and analyzed by MMS. Less than one spill ≥1,000 bbl is projected to occur in the offshore GOM for a typical future year from the extensive tanker and barge operations. Spill sizes for the spills projected ≥1,000 bbl are derived from median spill sizes for the particular sources found in Anderson and LaBelle (2000).

The data for spills <1,000 bbl that occur annually offshore and are not related to OCS operations was obtained from Dickey (2006) and analyzed by MMS. The estimated number was 1,000-1,300 spills <1,000 bbl occurring offshore annually from all non-OCS sources. The sources of these spills include spills from fishing boats, unclassified vessels, recreational vessels, and unknown sources. The assumed spill size of 5 bbl was derived by an analysis of all USCG data for spills in the size ranges of 1 to <1,000 bbl.

4.1.3.4.4.6. OCS-Related Coastal Spills

The MMS does not regulate the operations that could spill oil in the coastal zone and does not maintain a database on these spills. The MMS relies on spill data obtained from the *Pollution Incidents In and Around U.S. Waters A Spill/Release Compendium: 1969–2001* (USDOT, Coast Guard, 2006b) and by request from USCG. However, these databases do not differentiate between spills associated with OCS and non-OCS activities. The MMS used several methods to describe coastal spills. The MMS uses the total annual spill occurrence record for the Gulf area to estimate the number of coastal oil spills attributable to the OCS Program. The volume percentage related to OCS operations of the total volume of crude oil produced or transported in the Gulf area was used to approximate the percentage of spills likely to have occurred as a result of OCS oil-handling operations. Based on these percentages, future spill risk is projected. .

Table 4-13 provides the MMS's projections of the number of spills that will occur in the coastal waters of the GOM (State offshore and inland coastal waters) in a typical future year as a result of operations that support the OCS Program. Less than one spill per year of ≥1,000 bbl related to the proposed activity on the OCS is estimated to occur in coastal waters. Such a spill would only occur about once every 6 years. A spill ≥1,000 bbl would likely be from a pipeline accident. Roughly 40-50 spills per year of <1,000 bbl related to the proposed activity on the OCS are estimated to occur in coastal waters.

It is assumed that the spill risk would be widely distributed in the coastal zone, but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. Based on an MMS analysis of the USCG data on all U.S. coastal spills by volume, 42 percent of OCS coastal spills will occur in State offshore waters, 1.5 percent will occur in Federal offshore waters, and 57 percent will occur in inland waters. It is assumed all offshore coastal spills will contact land and proximate resources.

For OCS coastal spills <1,000 bbl, a spill size of 5 bbl is assumed; for OCS coastal spills ≥1,000 bbl, a spill size of 4,200 bbl is assumed. These assumed sizes are based on analysis of the USCG spill database for the spill size ranges of 1 to <1,000 bbl and on composites of the median size of a pipeline spill and a barge spill (Anderson and LaBelle, 2000), which are the two most likely sources of OCS-related spills that would occur in coastal waters and be ≥1,000 bbl.

4.1.3.4.4.7. Non-OCS-Related Coastal Spills

Using the same analysis described above, MMS also estimated the number of spills that are likely to occur in the coastal zone from non-OCS sources (**Table 4-13**).

Non-OCS-related coastal spills primarily occur from vessel accidents. Vessel accidents can spill oil from the tanks of import/export tankers while at ports or in bays and harbors; from the cargo tanks of barges and tank vessels that transport crude oil and petroleum products along channels, bayous, rivers, and especially while traversing the GIWW; and from fuel tanks of all other types of vessels, such as recreational boats or grain tankers. Other sources include spills during pipeline transport of petroleum products; crude oil; State oil and gas facilities; petrochemical refinery accidents; and from storage tanks at terminals.

A coastal non-OCS Program spill ≥1,000 bbl occurred roughly once every two years in the 1985-2001 USCG records. This is a very rough estimate due to the infrequent occurrence of a spill of this size in coastal waters. Coastal non-OCS Program spills <1,000 bbl occurred annually at a rate of 400-600 per year in the 1996-2001 USCG data. Many of the reported spills are from an unknown source. Based on an MMS analysis of U.S. spill data maintained by the USCG (USDOT, Coast Guard, 2001), the historical percentages of coastal spill occurrences in different waterbody types were calculated to be as follows: 47 percent have occurred in rivers and canals; 18 percent in bays and sounds; and 35 percent in harbors.

4.1.3.4.4.8. Other Sources of Oil

Volatile organic components (VOC's) present in the crude or refined hydrocarbons escape to the atmosphere during all phases of production, transportation, and consumption. They are then deposited into surface waters through wet and dry deposition and gas absorption. In both coastal and offshore areas, the greatest amount of VOC release to the atmosphere is during the consumption of petroleum, and sources include emissions during internal combustion, from power generating plants, and from industrial manufacturing. In the offshore OCS, 8,400 bbl (1,200 tonnes) are released to the western GOM and 11,200 bbl (1,600 tonnes) are released to the eastern GOM (NRC, 2003). These totals include emissions of VOC from petroleum consumption during from shore-based, coastal, and marine activities, which are then transported and deposited in the offshore waters.

On occasion, aircraft carry more fuel than they can safely land with so fuel is jettisoned into offshore marine waters. The amount of 1,120 bbl (160 tonnes) per year was estimated for the combined offshore western and eastern GOM.

Air pollution issues have prompted the USEPA to address the incomplete combustion of fuel and fuel additives in two-stroke engines, including outboard engines, lawn mowers, chain saws, and jet skis. The increased population in coastal areas uses an increased number of recreational water vessels such as motor boats and jet skis. *Oil in the Sea* (NRC, 2003) was able to quantify losses of petroleum hydrocarbons from recreational vessels to the coastal waters of the western and eastern GOM as 5,390 bbl (770 tonnes per year). It is interesting to note that the amount of petroleum hydrocarbons released from recreational vessels is about equal to the amount released by spills from tank vessels or coastal facilities.

4.2. Environmental and Socioeconomic Impacts of the Proposed Gulf Sales and Alternatives – Routine Events

4.2.1. Alternatives for Proposed Western Gulf Sales 204, 207, 210, 215, and 218

4.2.1.1. Alternative A — The Proposed Actions

4.2.1.1.1. Impacts on Air Quality

The following activities would potentially affect air quality: platform construction and emplacement; platform operations; drilling activities; flaring; seismic-survey and support-vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in **Chapters 3.1.1** (description of the coastal air quality status of the Gulf coastal area), **4.1.1.6** (air emissions), **4.1.1.9** (hydrogen sulfide), and **Appendix A.3** (description of the meteorology of the northern GOM). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and the mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and nitrogen dioxide constitute nitrogen oxides (NO_x) emissions. Nitrogen oxides, a by-product of all combustion processes, are emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation (i.e., acid rain).

Carbon monoxide (CO) is a by-product of incomplete combustion, primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood, reducing the transfer of oxygen within the body. CO particularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide (SO_2) may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide reacts in the atmosphere, principally with water vapor and oxygen, producing sulfuric acid, which along with nitric acid are the major constituents of acid rain. Acid rain can be harmful to animals, vegetation, and materials. The flaring of natural gas containing hydrogen sulfide (H_2S) and the burning of liquid hydrocarbons containing sulfur (**Chapter 4.1.1.9**) results in the formation of SO_2. The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. The natural gas in deepwater reservoirs has been mainly sweet (i.e., low in sulfur content), but the oil averages between 1 and 4 percent sulfur content by weight. By far, most of the documented production of sour gas (i.e., high sulfur content) lies within 150 km (93 mi) of the Breton Wilderness Area.

Flaring of sour gas is of concern because it could significantly impact onshore areas, particularly when considering the short-duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid hydrocarbon fuel is the primary source of sulfur oxides (SO_x), when considering the annual averaging period; however, impacts from high-rate well cleanup operations can generate significant SO_2 emissions. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hr and 24-hr averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the postlease process.

Volatile organic compounds (VOC's) are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's is the vents on glycol dehydrator stills.

Particulate matter, also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. The size of particles is directly linked to their potential for causing health problems. The USEPA is concerned about particles that are 10 micrometers (mm) in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. The USEPA groups particle pollution into two categories:

- "Coarse particles," such as those found near roadways and dusty industries, range in size from 2.5 to 10 mm in diameter.
- "Fine particles," such as those found in smoke and haze, have diameters smaller than 2.5 mm. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries, and automobiles react in the air.

The PM_{10} can also affect visibility, primarily because of the scattering of light by the particles and, to a lesser extent, light absorption by the particles. This analysis considers mainly total suspended particulate (PM_{10}) matter.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the troposphere (i.e., lower level of the atmosphere) from complex chemical reactions involving VOC's and NO_x in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who work or exercise strenuously outdoors are particularly sensitive to elevated ozone concentrations.

Emissions of air pollutants would occur during exploration, development, and production activities. The profile of typical emissions for exploratory and development drilling activities (**Chapter 4.1.1.6**) shows that emissions of NO_x are the most prevalent pollutant of concern. These emission estimates are based on a drilling scenario of a 3,674-m (12,055-ft) hole during exploration activities and a 3,050-m (10,000-ft) hole during development activities. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole.

Platform emission rates for the GOM region (**Chapter 4.1.1.6**) are provided from the 2000 emission inventory of OCS sources compiled by MMS (Wilson et al., 2004). This compilation was based on information from a survey of 3,154 platforms from 93 companies, which represented an 85 percent response rate. Since these responses included all the major oil and gas production facilities, they were deemed representative of the type of emissions to be associated with a platform. The NO_x and VOC's are the primary pollutants of concern, since both are considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were taken from the OCS emission inventory (Wilson et al., 2004).

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the wellbore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions table and in the modeling analysis (since platform emissions included flaring along with all other sources).

Accidents, such as oil spills, blowouts and pipeline ruptures, are another source of emissions related to OCS operations. The potential impacts from these accidental events are discussed in **Chapter 4.4.1**.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing net wind circulation. During summer, the wind regime in the WPA is predominantly onshore at mean speeds of 3-5 m/sec (6.7-11.2 mph). Average winter winds are predominantly offshore at speeds of 4-8 m/sec (8.9-17.9 mph).

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the WPA (Florida A&M University, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions; these stagnant conditions generally result in the worst periods of air quality. Although mixing height information throughout the GOM is scarce, measurements near Panama City (Hsu, 1979) show that the mixing height can vary between 400 and 1,300 m, with a mean of 900 m (2,953 ft). The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Proposed Action Analysis

The OCS emissions in tons per year for the criteria pollutants as a result of the proposed action are indicated in **Table 4-17**. The major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. The drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 40-day drilling period. Support activities for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and the offshore facilities; a smaller percentage of the emissions occur during idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

The total pollutant emissions per year are not uniform. At the beginning of the proposed activities, emissions would be the largest. Emissions peak early on, as development and production start relatively quickly, leading to increased production. After reaching a maximum, emissions would decrease as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

The MMS regulations (30 CFR 250.303) establish 1-hr and 8-hr significance levels for CO. A comparison of the projected emission rate to the MMS exemption level would be used to assess CO impacts. The formula to compute the emission rate in tons/yr for CO is $3{,}400 \cdot D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility.

Ozone impacts, which were studied in the GOM Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas including the Houston/Galveston, Port Arthur/Lake Charles, and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under a proposed action would not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller, and not interfere with the States' scheduled compliance with the National Ambient Air Quality Standards (NAAQS) (Systems Applications International et al., 1995). Additionally, 30 CFR 250.303(f)(2) requires that if a facility would significantly impact (defined as exceeding the MMS significance levels) an onshore nonattainment area, then it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well. The new 8-hour ozone standard (0.085 ppm) has been fully implemented as of August 2005. It is more stringent than the previous 1-hour standard, but did not result in more areas being classified as nonattainment for ozone. In response to the new ozone standard, updated ozone modeling was performed using a preliminary Gulfwide emissions inventory for the year 2000 to examine the O_3 impacts with respect to the new 8-hour ozone standard. Two modeling studies were conducted, one modeling study focused on the coastal areas of Louisiana extending eastward to Florida (Haney et al., 2004). This study showed that the impacts of OCS emissions on onshore O_3 levels were very small, with the maximum contribution of 1 ppb or less to locations where the standard was exceeded. The other modeling effort dealt with O_3 levels in Southeast Texas (Yarwood et al., 2004). The results of this study indicated a maximum contribution of 0.2 ppb or less to areas exceeding the standard.

Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible. It is estimated that over 99 percent of the gas and oil would be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer would be small, as would the associated exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Louisiana (Marine Vapor Recovery Act, 1989: LAC: III.2108). Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible.

The MMS studied the impacts of offshore emissions using the Offshore and Coastal Dispersion (OCD) Model. Three large areas in the WPA were modeled. The limiting factor on the size of each area was the run time needed to process the number of sources. The areas modeled were offshore Corpus Christi Bay, Matagorda Bay, and Galveston Bay. The receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. Emissions for a proposed action were projected and compared to the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. Only the onshore maximum concentrations reported for all of the runs are discussed. The results of the runs are reported in **Tables 4-18 and 4-19**. The results are also compared with the federally allowable increases in ambient concentrations as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Table 4-17 list the highest predicted contributions to onshore pollutant concentrations from OCS activities, as well as the maximum allowable increases over a baseline concentration established under the air quality regulations. While the table shows that OCS activities would result in concentration increases that are well within the maximum allowable limits for a Class II area, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The PM_{10} are emitted at a substantially smaller rate than NO_2 and SO_2; hence, impacts from PM_{10} would be expected to be even smaller since chemical decay was not employed in this dispersion modeling. A proposed action in the WPA would represent a small portion of the total OCS activity in the WPA; therefore, emissions from activities resulting from a proposed action would be substantially below the maximum allowable limits for a Class II area.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with the size in the range of 1 to 2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute to the visibility impairment in the Gulf coastal areas. Since future air emission from all sources in the area are expected to be about the same level or less, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

The Breton National Wilderness Area is a Class I air quality area administered by U.S. Fish and Wildlife Service (FWS). Under the Clean Air Act, MMS would notify the FWS and National Park Service if emissions from proposed projects may impact the Breton Class I area. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km (62 mi) of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are expected to be well within the NAAQS. A proposed action would have only a small effect on ozone levels in ozone nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the Prevention of Significant Deterioration (PSD) Class II areas.

4.2.1.1.2. Impacts on Water Quality

The routine activities that would impact water quality include the following:

- discharges during drilling of exploration and development wells;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- workovers of wells,
- service vessel discharges; and
- nonpoint-source runoff.

4.2.1.1.2.1. Coastal Waters

Proposed Action Analysis

In coastal waters, the water quality would be impacted by the discharges from the service vessels in port. The types of discharges and regulations were discussed in **Chapters 4.1.1.4.8** and **4.1.2.2.2**. Most discharges are treated or otherwise managed prior to release. In coastal waters, bilge and ballast water may be discharged with an oil content of 15 ppm or less. The USCG Ballast Water Management Program may apply to some vessels and is designed to prevent the introduction on non-indigenous (invasive) species. The discharges would affect the water quality locally. Estimates of the volume of bilge and ballast water that may be discharged are not available.

Supporting onshore facilities discharge into local wastewater treatment plants and waterways during routine operations. The types of onshore facilities were discussed in **Chapter 4.1.2.2.1**. All point-source discharges are regulated by the USEPA, which is the agency responsible for coastal water quality, or the USEPA-authorized State agency. The USEPA NPDES storm water effluent limitation guidelines control storm-water discharges from support facilities. Nonpoint-source runoff, such as rainfall, which has drained from infrastructure such as a public road, may contribute hydrocarbon and trace-metal pollutants. Data are not available to make estimates of the impact from this type of discharge.

Summary and Conclusion

The primary impacting sources to water quality in coastal waters are point-source and storm water discharges from support facilities, vessel discharges, and nonpoint-source runoff. The impacts to coastal water quality from a proposed action should be minimal as long as all existing regulatory requirements are met.

4.2.1.1.2.2. Marine Waters

Proposed Action Analysis

Drilling Muds and Cuttings

The drilling of exploratory and development wells results in the discharges of drilling fluids, called "muds," and cuttings. Although muds and cuttings have different characteristics, their impacts are discussed together since they are simultaneously discharged when WBF is used. Only cuttings wetted with SBF are permitted for discharge when SBF is used. The USEPA NPDES permits restrict the type and amount of mud and cuttings that can be discharged. The WPA sale area is under the jurisdiction of USEPA Region 6. The MMS estimates that a proposed action would result in 42-66 exploratory and delineation wells and 155-221 development wells drilled over the life of the proposed action. It is assumed that 80 percent of the wells will be drilled with SBF and 20 percent will be drilled with WBF.

Most studies of cuttings volumes generated when drilling with WBF have determined a cuttings volume in the range of 1,500-2,500 bbl of cuttings generated per well (USEPA, 1993a and b; Avanti Corporation, 1997). The volume of WBF used and the assumed discharge per well is about 7,000-9,700 bbl (USEPA, 1993). The following cuttings volumes were determined in studies prior to the permitting of SBF use: 565 bbl for a shallow development well; 855 bbl for a deep development well; 1,184 bbl for a shallow exploratory well; and 1,901 bbl of cuttings for a deep exploratory well (USEPA, 2000). Drilling as a result of the proposed action with WBF would create 78,000-173,000 bbl of cuttings and 272,000-559,000 bbl of WBF waste depending upon the well depth and washout rate (USEPA, 1993; Avanti Corporation, 1997; USEPA 2000). Drilling as a result of the proposed action with SBF would create 109,000-250,000 bbl of cuttings. Although the discharge of SBF fluid is not permitted, the discharge of cuttings containing a small percentage of adhered SBF is permitted.

The fate and effects of WBF and cuttings have been extensively studied throughout the world (Engelhardt et al., 1989). The primary environmental concerns associated with WBF are the increased turbidity in the water column, alteration of sediment characteristics because of the addition of coarser material from the cuttings, and trace metals. Occasionally, formation fluids may be discharged with the cuttings, adding hydrocarbon contamination, which may require treatment before discharge. The WBF are rapidly dispersed in the water column immediately after discharge, and the solids descend to the seafloor (Neff, 1987). The greatest effects to the benthos are within 100-200 m (328-656 ft), primarily due to the increased coarsening of the sediment by cuttings. Most of the components of the WBF have low toxicity with the exception of some trace metals. Barium is the major element in the mud because of the required large amounts of barite used, but trace amounts of chromium, copper, cadmium, mercury, lead, and zinc are also present. The trace mercury concentrations in barite are bound in sulfur compounds and not available for biological methylation or subsequent bioconcentration (Trefrey et al., 2002). Significant elevations of all these metals except chromium were observed within 500 m (1,640 ft) of six GOM drilling sites on the continental shelf (Boothe and Presley, 1989). The USEPA guidelines limit the levels of cadmium and mercury in stock barite to 3.0 mg per kilogram (kg) and 1.0 mg/kg (dry weight), respectively. A study of chronic impacts from oil and gas activities (Kennicutt, 1995) determined that metals from discharges, including mercury and cadmium, were localized to within 150 m (492 ft) of the structure. Highest levels of metal contaminants were attributed to a platform where discharges are shunted to within 10 m (33 ft) of the bottom.

Cuttings wetted with SBF do not disperse readily in the water column and, therefore, are not expected to adversely affect water quality. The greater the percentage of SBF removed from the cuttings prior to discharge, the more the discharge disperses similarly to WBF and WBF cutting. Since the SBF settle very close to the discharge point, the local sediments are affected. The primary effects are alteration of sediment grain size, and addition of organic matter, which can result in temporary, localized anoxia while the SBF degrade and smothering of benthic organism. In a study of shelf and slope locations where cuttings wetted with SBF had been discharged, the cuttings were deposited within a 100- to 250-m distance from the discharge point (CSA, 2004). The cuttings were identifiable in the impacted sediment because they were a different size and composition from the naturally occurring sediment. Elevated barium concentrations because of barite were also present. The SBF's are synthesized hydrocarbons rather than a petroleum product and initially the area is organically enriched. Over time, bacteria and fungi decompose the SBF. During biodegradation, oxygen is depleted and anaerobic processes take over. In comparison to background sediments, the SBF-enriched, surficial sediments become anoxic and indicators of anaerobic respiration, such as sulfide and ammonia, increase in concentration. As SBF concentrations decrease, the impacted sediments begin to recover. Bioaccumulation tests also indicate that SBF and their degradation products should not significantly bioaccumulate. It is expected that discharged cuttings should degrade within 2-3 years after cessation of discharge (Neff et al., 2000; CSA, 2004).

The MMS recently completed a field study of four drilling sites located on the slope in water depths of 1,033-1,125 m (3,389-3,691 ft) (CSA, 2006). Sample collection before and after exploration or development drilling documented the drilling-related changes to sediment at near-field and far-field locations. Sediment barium concentrations were typically enriched by greater than 10 fold at near-field versus far-field samples as a result of drilling. The average Viosca Knoll Block 916 predrilling sediment barium concentration was 0.09-0.1 percent barium and increased by 30-fold following drilling. Concentrations of other metals—Hg, Zn, As, and Pb—were elevated in 6-15 percent of near-field samples relative to far-field samples. An increase in sediment SBF due to the discharge of SBF-wetted cuttings was noted, although discharges had ceased 5 months to 2 years prior to sample collection. Elevated TOC and anoxic conditions corresponded with the presence of SBF. Concentrations of TOC were typically about one-third greater in near-field sediments relative to far-field sediments. Sediment profile photography showed microbial mats at more near-field sites corresponding to organic enrichment from drilling discharges.

Produced Water

Produced water is the largest waste stream generated in oil and gas production. Produced water would impact water quality by adding hydrocarbons, trace metals, and biochemical oxygen demand to the environment. As discussed in **Chapter 4.1.1.4.2**, the volume of produced water discharged from a facility ranges from 2 to 150,000 bbl/day (USEPA, 1993a and b). The MMS scenario predicts that 87 percent of development wells will actually produce. Therefore, of the 155-221 development wells drilled, an estimated 134-193 wells will produce. From 2001 to 2005, the reported volume has averaged 0.084 MMbbl of produced water per well. Consequently, the proposed action is projected to introduce 11-16 MMbbl of produced water per year. The amount of oil and grease resulting from a proposed action can be estimated from the projected annual produced water volume. Assuming the produced water consistently contains a monthly oil and grease average of 29 milligrams/liter (the NPDES permit limit for oil and grease), the volume of added hydrocarbons would be 0.1-0.2 million pounds of oil and grease per year as the result of a proposed action.

The MMS estimates that 28-41 production structures would be installed as the result of a proposed action (**Table 4-2**). Each structure may have the capacity to receive and treat greater volumes of produced water from multiple wells than structures in shallower waters. Discharges from workovers and other activities are generally mixed with the produced water and therefore must meet the same criteria.

Several studies have been conducted to evaluate the effects of produced-water discharges from platforms on the surrounding water column, sediments, and biota (e.g., Rabalais et al., 1991; Kennicutt, 1995; CSA, 1997b). The GOOMEX study (Kennicutt, 1995) examined the effects of discharges at three natural gas platforms. Effects, including increased hydrocarbons, trace metals, and coarser grain size sediments, were observed within 150 m (492 ft) of the platforms. Localized hypoxia was observed during the summer months and attributed to stratification of the water column and increased organic material near the platform. The distribution of contaminants was patchy and there were several variables that could contribute to the observations, specifically sand from cuttings, hydrocarbons, and trace metals in the porewater. It was not possible to make a definitive judgment as to the precise source of observed toxic effects in the benthic community.

A bioaccumulation study (CSA, 1997c) examined trace metals and hydrocarbons in several fish and invertebrate species near platforms on the continental shelf. The produced-water discharge and ambient seawater were also analyzed for the same compounds. Of the 60 target chemicals, two (arsenic and cadmium) were measured in the edible tissues of mollusks at levels above the USEPA risk-based concentrations. The target organic compounds were not present in most tissue samples above the target level. However, radium isotopes were measured in 55 percent of the samples, but at low concentrations.

Measurements of radium in formation water range from 40 to 1,000 pCi/l. These values are greater than marine waters, but when formation waters are discharged offshore, the radium is rapidly diluted to ambient concentrations (Reid, 1980).

The amount of oxygen demanding pollutants in produced water was determined for produced water discharged into the hypoxic zone (Veil et al., 2005) as a requirement for the reissued NPDES general permit. The mean biochemical oxygen demand (BOD) was 957 mg/l, total organic carbon (TOC) was 564 mg/l, and total Kjeldahl nitrogen (TKN) was 83 mg/l in produced waters from the platforms located within the hypoxic zone. These loadings were less than 0.5 percent of the Mississippi and Atchafalaya River nutrient loading; so, although more research is in progress, produced water is not anticipated to contribute to the annual GOM summer hypoxic zone formation. Future activities in the shelf area where the hypoxic zone occurs are expected to focus on deep gas production. Gas completions generate less produced water than oil completions.

Platform Installation and Removal

The MMS estimates that 11-17 platforms would be removed using explosives as a result of the proposed action (**Table 4-2**). As with installation, platform removal would also result in localized sediment disturbance and an increase in turbidity within the water column. During explosive removal, gaseous by-products including carbon dioxide, nitrogen, and carbon monoxide would be released. The increase of gaseous by-products from explosives in the water would cause very short-term, minor alterations to the dissolved gas concentrations in the water in the immediate area of the explosion.

The MMS estimates that 9-14 platforms would be removed by methods other than explosives as a result of the proposed action. Abrasive cutting removal uses seawater and an abrasive, either copper slag or industrial garnet. These abrasives are inert solids that would be deposited on the seafloor along with metal cuttings. The presence of abrasive grit from platform removal would cause very short-term, minor increases in turbidity in the area of activity.

Other Impacting Activities

The installation of pipelines can increase the local total suspended solids in the water. These activities result in only a temporary adverse effect on water quality.

Supply-vessel traffic affects water quality through discharges of bilge water, ballast water, and domestic and sanitary wastes. Bilge water and sanitary wastes are treated before discharge. Ballast water is uncontaminated water but may come from a source with properties, such as lower or higher salinity, different from those of the receiving waters. Estimates of the volumes of these discharges are not available.

Summary and Conclusion

During exploratory activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. During installation activities, the primary impacting sources to water quality are sediment disturbance and turbidity. Impacting discharges during production activities are produced water and supply-vessel discharges. Regulations are in place to limit the levels of contaminants in these discharges. During platform removal, sediment disturbance, gaseous by-products of explosives, or abrasive grit from cutting are the impacting discharges. Impacts to marine waters from a proposed action should be minimal as long as regulatory requirements are followed.

4.2.1.1.3. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by activities resulting from a proposed action in the WPA are considered in **Chapters 4.2.1.1.3.1, 4.2.1.1.3.2, and 4.2.1.1.3.3**. Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The major, nonaccidental, impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, and construction and expansions of navigational canals, port facilities, processing facilities, pipelines, and pipeline-support facilities. The MMS has no direct regulatory authority over potential impact-producing factors or mitigation activities that may occur or be needed in the States' coastal zones.

4.2.1.1.3.1. Coastal Barrier Beaches and Associated Dunes

This section considers impacts from a proposed action in the WPA to the physical shape and structure of barrier beaches and associated dunes. The primary impact-producing activities associated with a proposed action that could affect barrier beaches and dunes include pipeline emplacements, navigation channel use (vessel traffic) and dredging, and use and construction of support infrastructure in these coastal areas. The following sections describe the sources and types of these potential impacts.

Pipeline Emplacements

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Pipeline landfall sites on barrier islands could accelerate beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from pipeline landfalls employing modern installation techniques, such as directional boring (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988).

Vessel Traffic and Dredging

Vessel traffic that may support a proposed action is discussed in **Chapter 4.1.1.8.4**. Navigation channels projected to be used in support of a WPA proposed action are discussed in **Chapter 4.1.2.1.9**. Navigation channels that support the OCS Program are listed in **Table 3-36**. Current navigation channels will not change as a result of a proposed action in the WPA. In addition, no new navigation channels will be required by a proposed action in the WPA.

Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion processes. Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Texas and Louisiana coast. According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr (8.46 ft/yr), compared with 0.95 m/yr (3.12 ft/yr) for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr (4.9 ft/yr), or 300 ha (741 ac) of landloss per year for the 700 km (435 mi) of OCS-related navigation channels in the WPA. Navigation channels through the sandbars at the mouths of flowing channels generally capture and remove sediments from the longshore sediment drift, if the cross-sectional area of the channel is too large for natural tidal and storm exchanges to keep swept clear. Periodic maintenance dredging is expected in existing OCS-related navigation channels through barrier passes and associated bars. Jetties designed to reduce channel shoaling and maintenance dredging of bar channels affect the stability of barrier beaches and dunes if those jetties or bar channels serve as sediment sinks that intercept sediment in longshore drift. Dredging removes sediment from the littoral sediment drift or routes around the beach immediately downdrift of the involved channel. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby ocean dump sites in the Gulf; however, these materials are increasingly being exploited for beneficial uses such wetlands or beach renourishment projects (**Chapter 4.1.3.2.1**).

Continued Use of Support Infrastructure

No onshore infrastructure used to support OCS operations has been constructed recently on barrier beaches in Texas or Louisiana, except for pipeline landfalls. The use of some existing facilities in support of a proposed action and subsequent lease sales in the WPA may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. They may also cause the accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts will last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified.

Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat.

Abandoned facility sites must be cleared in accordance with Federal, State, and local governmental and landowner requirements. All materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

Zero to one pipeline landfalls are projected as a result of a proposed action in the WPA. Should one be constructed, it will most likely be in EIA TX-2, where the large majority of the pipelines from the WPA come ashore. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, Federal and State regulatory programs and permitting processes encourage the use of directional boring technology to greatly reduce and perhaps eliminate impacts to barrier beaches or dunes. Therefore, effects on barrier beaches and dunes from pipeline laying activities associated with a proposed action in the WPA are expected to be minor or nonexistent. These impacts are considered to be negligible.

The average contribution of a proposed action in the WPA to OCS-related vessel traffic in navigation canals is expected to be small (1-2%). Turner and Cahoon (1988) found that OCS traffic in general comprises a relatively small percentage (~12%) of the total commercial traffic using navigation channels. Thus, the allocation of navigation channel impacts to OCS activities is small, and the contribution from a proposed action is even smaller. Erosion of coastal barrier beaches and associated dunes from vessel traffic associated with a proposed action in the WPA are expected to be negligible.

Adverse impacts due to maintenance dredging of navigation channels can be mitigated by discharging dredged materials onto barrier beaches or strategically into longshore sediment currents downdrift of maintained channels or by using the dredged material to create wetlands. Adverse impacts of sediment sinks created by jetties can be further mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment. Sediment traps that are created by dredging artificially large bar channels may be mitigated by reassessing the navigational needs of the port and reducing the depth of the channel. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies. Effects on coastal barrier beaches and associated dunes associated with dredging from a proposed action in the WPA are expected to be restricted to minor and very localized areas downdrift of the channel.

A gas processing plant associated with a proposed action in the WPA would not be expected to be constructed on barrier beaches. Effects on coastal barrier beaches and associated dunes associated with continued use of existing OCS gas processing plants and pipeline infrastructure from a proposed action in the WPA are expected to be restricted to minor and very localized areas downdrift of the facility or landfall site.

Summary and Conclusion

In summary, effects to coastal barrier beaches and associated beaches from pipeline emplacements, navigation channel use and dredging, and construction or continued use of infrastructure in support of a proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 gas processing plants and 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

4.2.1.1.3.2. Wetlands

This section considers impacts from a proposed action in the WPA to coastal wetlands and marshes. The primary impact-producing activities associated with a proposed action that could affect wetlands and marshes include pipeline emplacements, construction and maintenance, navigation channel use (vessel traffic) and maintenance dredging, and use and construction of support infrastructure in these coastal areas. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigation traffic and additional onshore development encouraged by increased capacities of navigation channels.

Impacts from a proposed action in the WPA to coastal wetlands and marshes would occur primarily in Texas. Impacts from a proposed action in the CPA to coastal wetlands and marshes would occur primarily in Louisiana, and are discussed in **Chapter 4.2.2.1.3.2**.

The Texas Gulf Coast is comprised of a broad range of saline, brackish, intermediate, and fresh marsh wetlands, including wet prairies, forested wetlands, barrier islands, mud flats, estuarine bays, bayous, and riparian wooded areas. Saline and brackish marshes are most widely distributed south of the Galveston Bay area, while intermediate marshes are the most extensive marsh type east of Galveston Bay. The most extensive wetlands along the Texas coast are located in the Strandplain-Chenier Plain System that runs from eastern Chambers County, Texas, through Vermilion Parish, Louisiana.

Estimates of wetland acreage in the 19 coastal counties in 1979 range from 611,760 ac of fresh, brackish, and salt marshes (Texas Parks and Wildlife Dept., 1988) to approximately 1.8 million ac of salt, brackish, fresh, forest, and scrub-shrub wetlands (Field et al., 1991). The Texas Parks and Wildlife Dept. estimates that 35 percent of the State's coastal marshes were lost between 1950 and 1979 (Texas Parks and Wildlife Dept., 1988; Texas General Land Office, 2001). The total loss of marshes in the river deltas since the 1950's amounts to about 21,000 ac, or 29 percent, of the river-delta marsh (White and Calnan, 1990). In the Galveston Bay system, from the 1950's to 1989, there was a net loss of 33,400 ac, which amounts to 19 percent of the wetlands that existed in the 1950's (White et al., 1993). This rate of loss has declined over time, from about 1,000 ac per year between 1953 and 1979 to about 700 ac per year between 1979 and 1989.

Pipeline Emplacememt

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Many OCS pipelines make landfall on Texas' barrier island and wetland shorelines. Approximately 8,000 km (4,971 mi) of OCS-related pipelines cross marsh and uplands (Johnston and Cahoon, in preparation). Wetlands protect pipelines from waves and ensure that the lines stay buried and in place (also see **Chapter 4.1.2.1.7,** Coastal Pipelines). Existing pipelines have caused direct landloss averaging between 2.5 ha/km (10 ac/mi) (Bauman and Turner, 1990) and 4.0 ha/km (16 ac/mi) (Johnston and Cahoon, in preparation) of linear pipeline. Bauman and Turner (1990) indicated that widening of OCS pipeline canals does not appear to be an important factor for total net wetland loss in the coastal zone because few pipelines are open to navigation (see cumulative impacts in **Chapter 4.5.3.2)**. Modern pipeline emplacement techniques, such as avoidance of wetlands areas and directional boring under wetlands, result in zero (0) to negligible impacts.

Historically, a major concern associated with pipeline construction through wetlands was disturbance caused by backfilling. Pipeline canals were backfilled with the materials originally dredged while digging the canal. The major factors determining the success of backfilling as a means of restoration are the depth of the canal, soil type, canal dimensions, locale, dredge operator skill, and permitting conditions (Turner et al., 1994). Plugging the canal has no apparent effect on water depth or vegetation cover, with one exception—submerged aquatic vegetation was more frequently observed behind backfilled canals with plugs than in backfilled canals without plugs. Canal length and percentage of backfill returned has the greatest effect on the recovery of vegetation cover (Turner et al., 1994). While investigating backfilling canals as a wetland restoration technique in coastal Louisiana, Turner et al. (1994) discovered that canals backfilled as mitigation for dredging done at another location are typically more shallow if they are older or in soils lower in organic matter. Vegetation recovery increases with an increased canal length and percentage of material returned. In areas where soils have high organic content, as in deltaic plains or the Chenier Plain, backfilling does not usually fill a canal completely.

The real loss of wetland habitat is difficult to determine because it depends on the pipeline emplacement technique used, amount of backfilling, time of year, and duration of construction. After pipelines are constructed and backfilled in Texas wetlands, a shallow channel is expected to remain where the canal passes through the wetland; after backfilling in the coastal areas of Louisiana, some open-water areas may remain. Approximately six years after backfilling has occurred, productivity of vegetation in areas directly over the pipeline is expected to be reduced. It is estimated that wetland habitat could be reduced by as much as 25 percent in Texas. For the same period of time (approximately six years), productivity of vegetation in a 2- to 3-m-wide strip of wetland on either side of the pipeline is expected to be reduced as much as 11 percent in Texas.

The MMS is presently conducting a study in conjunction with USGS-BRD to investigate coastal wetland impacts from the widening of OCS-related canals rates and the effectiveness of mitigation. At present, there is no known study addressing the effectiveness or longevity of canal-related mitigation. Also, MMS is currently identifying and mapping onshore OCS-related pipelines in the coastal regions around the Gulf including those in wetland habitats in Kenedy, Aransas, Calhoun, Matagorda, Brazoria, Galveston, and Orange Counties of Texas. With the OCS pipelines identified, this study will provide basic information for environmental impact assessments and for mitigation development by MMS and other Federal agencies.

Dredging

No new navigational channels are expected to be dredged as a result of a proposed action in the WPA. An increase in OCS deepwater activities, which require larger service vessels for efficient operations, is expected. This may shift some deepwater support activities to shore bases associated with deeper channels. Some of the ports that have navigation channels that can presently accommodate deeper-draft vessels may expand port facilities to accommodate these deeper-draft vessels, e.g., Port of Galveston.

Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels results in additional deposits material on existing dredged-material disposal banks; the effects of dredged-material disposal banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor aggravation of existing problems. Typically, some material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging will also temporarily increase turbidity levels in the vicinity of the dredging and disposal of materials, which can impact emergent wetlands, seagrass communities and associated habitats.

Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) hydraulic cutterhead suction dredge transfers sediments via connecting pipelines; and (2) clamshell bucket dredge transfers sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to the dredged material disposal site. Coarser sediment settles to the bottom where it spreads outward under the force of gravity; finer sediments may remain in suspension longer. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area. The dredged sediments are released into the area specified for disposal. This method usually produces positive relief features in the placement area.

Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged material (Rozas, 1992). Placement of this material alongside canals converts marsh to upland, an environment unavailable to aquatic organisms except during extreme tides. Dredge material can also form a barrier causing ponding behind levees and limiting circulation between canal waters and marshes to infrequent, high-water events (Swenson and Turner 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Kuhn et al., 1999; Turner et al., 1994; Rozas, 1992; Turner and Cahoon, 1987).

Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (**Chapter 4.1.3.2.1**). Given the "mission statement" of the COE, which requires it to take environmental impacts into consideration during its decisionmaking processes, increased emphasis has been placed on the use of dredged material for marsh creation. For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Navigational Channels and Vessel Traffic

Vessel traffic that may support a proposed action is discussed in **Chapter 4.1.1.8.4**. Most navigation channels projected to be used in support a WPA proposed action (**Chapter 4.1.2.1.9**) are shallow and are currently used by vessels that support the OCS Program (**Table 3-36**). Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process as evident along the Texas coast where heavy traffic using the Gulf Intracoastal Waterway (GIWW) has accelerated erosion of existing salt marsh habitat (Cox et al. 1997).

On average, 12 percent of traffic using OCS-related navigation channels is related to the OCS Program; therefore, impacts related to a proposed action should remain minimal. According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr (8.46 ft/yr), compared with 0.95 m/yr (3.12 ft/yr) for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr (4.9 ft/yr). Approximately 3,200 km (1,988 mi) of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf, exclusive of channels through large bays, sounds, and lagoons. About 700 km (435 mi) of these channels are found around the WPA; resulting in about 105 ha (259 ac) of landloss each year in the WPA.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks.

Disposal of OCS-Related Wastes

Produced sands, oil-based or synthetic-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities will be transported to shore for disposal. Sufficient disposal capacity is assumed to be available in support of a proposed action (**Chapter 4.1.2.1.6**). Discharging OCS-related produced water into inshore waters has been discontinued; all OCS-produced waters are discharged into offshore Gulf waters in accordance with NPDES permits or are transported to shore for injection. Produced waters are not expected to affect coastal wetlands (**Chapter 4.1.1.4.2**).

Because of wetland-protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in **Chapter 4.1.2.1** and **Table 4-9**. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to a proposed action; none will be in wetland areas. State and Federal permitting agencies discouraged the placement of new facilities or expansion of existing facilities in wetlands. Any impacts upon wetlands from existing facilities are expected to be mitigated.

Proposed Action Analysis

For a proposed action in the WPA, 0-1 pipeline landfalls are projected. Up to 2 km (1.2 mi) of onshore pipeline are projected to be constructed in coastal Texas in support of a proposed action in the WPA. In EIA's TX-1 and TX-2 (**Figure 4-2**), about 25 percent of new pipelines are assumed to occur in wetlands. Modern pipelaying techniques and mitigations, including directional drilling and wetlands avoidance, would result in zero to negligible impacts from such a project.

For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

On average, 12 percent of traffic using OCS-related navigation channels is related to the OCS Program, and a proposed action is expected to contribute 4-6 percent to this usage. The roughly 700 km (435 mi) of OCS-related navigation channels are expected to widen at approximately 1.5 m/yr (4.9 ft/yr). Based on percentage of use, a proposed action would thus contribute to about 0.44 ha (1.09 ac) of landloss per year. Therefore, impacts from vessel traffic related to a proposed action should remain minimal.

Because of wetland protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences. No effects to coastal wetlands from disposal of OCS-related wastes associated with a proposed action in the WPA are expected.

Summary and Conclusion

A proposed action in the WPA is projected to contribute to the construction of 0-1 new onshore pipelines. Modern pipelaying techniques and mitigations would be used for such a project and thus, the projected impact to wetlands from pipeline emplacement is expected to be negligible. As a secondary impact, some wetlands could potentially be converted to open water by continued widening of existing pipeline and navigational canals.

Maintenance dredging of navigation channels related to a proposed action is expected to occur with minimal impacts. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands.

Deepening an existing channel to accommodate larger service vessels may occur within the previously described environment(s) and could generate the creation of a small area of wetland that would be attributable to a proposed action.

Overall, activities associated with a proposed action in the WPA are expected to cause negligible to low impacts to wetlands. Secondary impacts to wetlands caused by existing pipeline and vessel traffic corridors will continue to cause landloss. However, their broad and diffuse distribution over coastal Texas makes it difficult to distinguish these impacts from other ongoing, non-OCS-related impacts to wetlands.

4.2.1.1.3.3. Seagrass Communities

Seagrasses in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass bed communities are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Although permanent meadows of perennial species occur in nearly all bay systems along the Texas Gulf Coast, the majority (79%) of the State's seagrass cover is found in the Laguna Madre (Pulich, 1998), with seagrasses currently covering about 243 km^2 (94 mi^2) in the upper portion of the Laguna Madre (Quammen and Onuf, 1993). Seagrass communities are largely excluded from bays north of Pass Cavallo where rainfall and inflows are high and salinity averages less than 20 ppt, as well as from the upper, fresher portions of most estuaries. Seagrass communities in the Laguna Madre constitute a unique resource that cannot be duplicated elsewhere on the Texas coast (Withers, 2001). Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays.

The OCS oil and gas activities that could adversely affect seagrass communities include pipeline construction and canals, dredging of new navigation channels, maintenance dredging and vessel usage of navigation channels (propeller scars, etc.), construction and maintenance of inshore facilities, oil spills, and spill-response and cleanup activities. The potential impacts of oil spills and spill-response and cleanup activities are discussed in **Chapter 4.3**.

Pipelines

The installation of 0-1 pipeline landfalls is projected as a result of a WPA proposed action (**Chapter 4.1.2.1.7**). Pipeline construction methods and disturbances are discussed in **Chapters 4.1.1.3.10.1 and 4.1.2.1.7**. Jetting of trenches for pipeline burial in water shallower than 60 m (200 ft) displaces sediments. The denser sediments fall out of suspension quickly; the finer sediments that decrease water clarity remain in suspension longer. Although the majority of materials resuspended by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and the density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Reduced water clarity can decrease plant density in seagrass beds, which in turn can further increase turbidity as the root, thatch, and leaf coverage decreases (Wolfe et al., 1988). The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow or community extent and productivity. As in maintenance dredging activities discussed below, activities from pipeline emplacement will reduce light, which is linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995).

The COE and State agencies take possible impacts to submerged vegetation into consideration during their review of pipeline permits. The permits for constructing pipelines require that turbidity impacts be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment. The permits also require surveys for locating seagrass beds of submerged vegetation, turbidity monitoring with reporting to the COE and State agencies, and immediate action taken to correct turbidity problems.

Maintenance Dredging

No new navigation channels are expected to be dredged as a result of a proposed action or OCS Program activities in the WPA. Maintenance dredging schedules vary from yearly to rarely and will continue indefinitely into the future. Deepwater activities are anticipated to increase, which will likely require greater use of larger service vessels for efficient operations and may cause greater use of shore bases associated with deeper channels. The ports that support these service bases presently accommodate deeper-draft vessels that support the OCS Program. The service bases are discussed in **Chapter 4.1.2.1.1**.

Impacts to seagrass and associated habitat can occur from periodic maintenance dredging of navigation channels. Changes in species composition are mostly the result of natural processes (i.e., succession) but have been prompted by moderation of salinity resulting from dredging of the Gulf Intracoastal Waterway (GIWW) and Mansfield Pass. Decreases in cover and biomass have also been occurring. In the upper Laguna Madre, shoalgrass cover decreased by 3.8 percent (9.4 km^2 [3.6 mi^2]) between 1988 and 1994, and shoalgrass biomass at depths >1.4 m (4.6 ft) decreased by 60 percent (Onuf, 1996). For the most part, these decreases have been attributed to brown tide occurrences that started in 1990 and continue in some parts of the system today. Changes in species composition due to succession have been most pronounced in the lower Laguna Madre, but a more troubling change is increased bare area. Overall, bare area has increased to 190 km^2 (73 mi^2), up 280 percent between 1965 and 1988 (Quammen and Onuf, 1993). Turbidity caused by maintenance dredging has been implicated in the decline of shoalgrass and increased bare areas in the lower Laguna Madre (Onuf, 1994). Light attenuation is responsible for most landscape-level losses, with scarring by vessel traffic also a concern. The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. Reduced light has been linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995). Dredging has been determined to be one of the major causes of light reduction that results in changes in seagrass cover, composition, and biomass. Changes in species composition resulting from dredging activities may affect resource availability for some fish and waterfowl that use seagrass habitat as nursery grounds.

Deepwater activities are anticipated to increase, requiring use of larger service vessels for efficient operations, which may shift greater emphasis to shore bases associated with deeper channels. Maintenance dredging schedules vary from yearly to rarely and will continue indefinitely into the future.

Vessel Traffic

Navigation traffic that may support a proposed action is discussed in **Chapter 4.1.2.1.9**. Most navigation channels projected to be used for a WPA proposed action are shallow and are currently used by vessels that support the OCS Program (**Table 3-37**). For example, the GIWW is dredged to an average depth of 4 m, but varies in depth between ports. Propwashing of shallow navigation channels by vessel traffic resuspends sediments, increasing the turbidity of nearby coastal waters.

Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors.

Proposed Action Analysis

Pipelines

Gas production and the great majority of oil production from a WPA proposed action is expected to be commingled in pipelines with other OCS production at sea before going ashore. Seagrass communities are not present in the Federal OCS waters, where most of the pipeline supporting a proposed action would be installed. The installation of 0-1 pipeline landfalls is projected as a result of a proposed action in the WPA (**Chapter 4.1.2.1.7**), with a potential landfall likely to be in or around Galveston County.

Although the majority of materials dredged by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Permit requirements of the COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation. Therefore, significant direct impacts to submerged vegetation by pipeline installation are expected to be very small and short term if they occur.

Maintenance Dredging

Denser dredged materials fall out of suspension quickly; less dense sediments settle to the water bottom slowly. These lighter bottom sediments are generally more easily resuspended by storms than were the original surface sediments. Therefore, for a period of time after dredging occurs, water turbidity will be greater than usual in the vicinity of the dredging. With time, this reoccurring, increased turbidity will decrease to pre-project conditions, as the lighter materials are either dispersed to deeper water by currents, where they are less available for resuspension, or they are consolidated into or under denser sediments.

For estuarine species that thrive in salinities of about 0.5-25 ppt, this elevated turbidity may not pose a significant problem because they have adapted to turbid, estuarine conditions. However, it could be a problem for seagrass beds in higher salinities and even for freshwater submerged aquatic vegetation that require clearer waters. Significantly reduced water clarity or shading for longer than about 4 days will decrease chlorophyll production. If such conditions continue for longer than about 2 weeks, plant density in the bed will begin to decrease. If plant density reduces significantly, further increases in turbidity will occur as the root, thatch, and leaf coverage decline.

Because much of the dredged material resulting from maintenance dredging will be placed on existing dredged material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging credited to a proposed action. Maintenance dredging for inshore navigational canals is only partly related to a proposed action. Dredging regulations by the COE and coastal States are designed to protect seagrass beds from impacts by maintenance dredging. Adherence to coastal regulations is expected to limit impacts on seagreass resources to a low level.

Vessel Traffic

Most of the navigation channels to be used for a proposed action are shallow. For that reason, propwashing related to a proposed action may substantially resuspend sediments in these areas. Navigational traffic using the GIWW along the Texas coast would resuspend sediments in numerous areas. A proposed action would represent a substantial percentage of existing traffic along the Texas coast. However, beds of submerged vegetation within the area of influence and other channels have already adjusted their configurations in response to turbidity generated there.

Vessel captains may cut corners of channel intersections or navigate across open water where they unexpectedly encounter shallow water where beds of submerged aquatic vegetation may occur. Propellers may damage a bed superficially by leaving a few narrow cuts. Damage may be as extensive as broadly plowed scars from the keel of a large boat accompanied by extensive propwashing; trampling by waders; and additional keel, prop, and propwash scars left by other vessels that assisted in freeing the first boat.

Summary and Conclusion

Most seagrass communities located within a WPA proposed action are located behind the barrier islands. These sparsely distributed in bays and estuaries along coastal Texas, including the Laguna Madre of Tamaulipas, Mexico. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat. The potential impacts from oil spills are discussed in **Chapter 4.4.3.3**.

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Therefore, impacts to submerged vegetation by pipeline installation are projected to be very small and short term. **Table 4-9** lists the projected number of additional OCS pipeline landfalls and their inshore lengths to be constructed as a result of a WPA proposed action.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a navigation channel's area of influence will have already adjusted their bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area or damage to an already stressed area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a WPA proposed action.

4.2.1.1.4. Impacts on Sensitive Offshore Benthic Resources

4.2.1.1.4.1. Continental Shelf Benthic Resources

4.2.1.1.4.1.1. Topographic Features

The topographic features sustaining sensitive offshore habitats in the WPA are listed and described in **Chapter 3.2.2.1.2**. A Topographic Features Stipulation similar to the one described in **Chapter 2.3.1.3.1** has been included in appropriate leases since 1973 and may, at the option of the Secretary, be made a part of appropriate leases resulting from this proposal. The impact analysis presented below for a proposed action in the WPA includes the proposed biological lease stipulation. As noted in **Chapter 2.3.1.3.1**, the stipulation establishes a No Activity Zone in which no bottom-disturbing activities would be allowed and areas around the No Activity Zones (in most cases) within which shunting of drill cuttings and drilling fluids to near the bottom would be required.

The potential impact-producing factors on topographic features of the Western Gulf are anchoring (**Chapter 4.1.1.3.3.1**), infrastructure emplacement (**Chapters 4.1.1.3.1 and 4.1.1.3.2**), drilling-effluent and produced-water discharges (**Chapters 4.1.1.4.1 and 4.1.1.4.2**), and infrastructure removal (**Chapter 4.1.1.3.3**). Impacts from oil spills and blowouts are discussed in **Chapter 4.4.4.1.2**. These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features in the WPA.

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be the greatest threat to the biota of the offshore banks in the Gulf (Bright and Rezak, 1978; Rezak et al., 1985). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the Topographic Feature Stipulation.

Infrastructure emplacement and pipeline emplacement could resuspend sediments. The proposed Topographic Features Stipulation requires all bottom-disturbing activity to be at least 152 m (500 ft) away from the boundaries of No Activity Zones. This would prevent these activities from occurring in the No Activity Zone and preclude most resuspended sediments from reaching the biota of the banks.

Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (10,542 bbl/exploratory well; 7,436 bbl/development well) (USEPA, 1993a and b), potential impacts on biological resources of topographic features should be expressly considered if drill sites occur in blocks directly adjacent to No Activity Zone boundaries. Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants. The USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone. **Chapters 4.1.1.4.1 and 4.2.1.1.2.2** detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and extent measured in the past because current USEPA regulations and NPDES permits contain more restrictive limits (**Chapter 4.2.1.1.2.2**). The effects of past muds and cutting discharges are discussed in **Chapter 4.2.1.1.2.2**. A brief overview of the potential impacts on topographic features by drilling discharges follows.

Water-column turbidity and the smothering of sessile invertebrates of topographic features caused by drilling muds and cuttings are of little significance for two reasons. First, the Topographic Features Stipulation limits impact through the No Activity Zone and shunting restrictions imposed within the 1-Mile Zone, 3-Mile Zone, 4-Mile Zone, and 1,000-Meter Zone, as well as the USEPA general NPDES permit special restrictions on discharge rates in blocks adjacent to a No Activity Zone or sensitive areas, which necessitates photodocumentation by industry. Secondly, studies have shown the rapid dispersion of drilling fluid plumes in the OCS within a 1,000-m (3,281 ft) range of the discharge point and the resilience of sessile invertebrates exposed or smothered with an extreme range of concentrations of drilling muds (Kendall, 1983). For local accumulation of contaminants, assumptions are that trace-metal and petroleum contamination resulting from drilling muds and cuttings will occur mainly within a few hundred to a couple of thousand meters downcurrent from the discharge point and can be found up to

3,000 m (9,842 ft) downcurrent in shallow waters. Concentrations of contaminants decrease with an increasing distance from the drilling site. By examining sediments surrounding three gas production platforms (within a 100-m (328 ft) radius), Kennicutt et al. (1996) found low concentrations of petroleum and trace metal contaminants that would be unlikely to induce a biological response in benthic organisms. The highest trace metal concentrations originating from discharged drilling fluids found around platforms were strongly correlated with the presence of sand-size sediments. Shallow sites are subject to comparatively greater sediment removal and resuspension due to a high-energy environment. Contaminants from previous discharges under less restrictive conditions have been found to remain in sediments surrounding drill sites for as long as 10 years (Kennicutt et al., 1996). Toxic effects could be incurred by benthic organisms of topographic features found in the vicinity of a No Activity Zone boundary if the plume flow of an operation is consistently directed toward that boundary. Should effects occur, they would potentially persist for as long as 10 years following the onset of discharges.

Produced waters could also represent a significant potential source of impact to the biota of topographic features, considering produced water constitutes the largest single discharge during routine oil and gas operations. The USEPA general NPDES permit restrictions on the discharge of produced water help to limit the impacts on biological resources of topographic features. Past evaluation of the bioaccumulation of offshore produced-water discharges conducted by the Offshore Operators Committee (1997) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals (2 species of molluscs and 5 species of fish). Because high-molecular, polycyclic aromatic hydrocarbons (PAH's) are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and they were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers. A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in **Chapter 4.2.1.1.2**.

The impacts of structure removal on topographic features can include water turbidity, sediment deposition, and explosive shock-wave impacts. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity. The deposition of resuspended sediments would occur much in the same manner as discussed for discharges of muds and cuttings, choking and causing mortality of sessile benthic organisms. Turbidity could both reduce light levels and obstruct filter-feeding mechanisms, leading to reduced productivity, susceptibility to infection, and mortality. The shock waves produced by the explosive structure removals could also harm associated biota. Corals and other sessile invertebrates have a high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m away from the detonation of 135-kg (298 lb) charges in open water incurred a 5-percent mortality rate. Crabs distanced 8 m away from the explosion of 14-kg (31 lb) charges in open water had a 90-percent mortality rate. Few crabs died when the charges were detonated 46 m (151 ft) away. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock-wave is significantly attenuated in mud compared with in the water column, where it is known to impact fish up to 60 m (197 ft) away from an 11.3-kg (24.9-lb) charge blasted at a 100-m (328-ft) water depth (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m (15 ft) below the seabed, as required by MMS regulations would further attenuate blast effects (Wright and Hopky, 1998). However, recent evidence shows that attenuation of blast effects is dependent on sediment characteristics. Reliable determination of blast effects must be from *in situ* measurements or modeling based on sediment characteristics. In the absence of these methods, environmental impact evaluations should be based on attenuation equivalent to charges detonated on the bottom in open water (CSA, 2004). Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young.

The *Programmatic Environmental Assessment for Structural Removal Activities* (USDOI, MMS, 1987) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the GOM. Impacts on the biotic communities, other than those on or directly associated with the platform, would be limited by the relatively small size of individual charges (normally 22.7 kg (50 lb) or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m (15 ft) below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive). The stipulation discussed above would preclude platform installation within 152 m (500 ft) of the No Activity Zone, thus preventing adverse effects from nearby removals.

Proposed Action Analysis

All of the 21 topographic features (shelf edge banks, low-relief banks, and south Texas banks) in the WPA are found in waters less than 200 m (656 ft) deep. They represent a small fraction of the Western Gulf area.

As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements, anchoring activities, and removals. Yet, operations outside the No Activity Zones could still affect topographic features through drilling effluent discharges and produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in **Chapter 4.4.4.1.2**.

For a WPA proposed action, 63-104 exploration/delineation and development wells are projected for offshore Subareas W0-60 and W60-200. With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zones. Most drilling discharges would be shunted to within 10 m (33 ft) of the seafloor either within the 1,000-Meter Zone, 1-Mile Zone, 3-Mile Zone, or 4-Mile Zone (depending on the topographic feature) around the No Activity Zone (see **Chapter 2.3.1.3.1** for specifics). This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It has been estimated, however, that drilling effluents and produced waters could reach and impact topographic features 5-10 times during the life of this proposal. The severity of such impacts would probably be primarily sublethal such that there may be a disruption or impairment of a few elements at the regional or local scale but no interference to the general system performance. Recovery to pre-impact conditions should take place within 2 years.

For a WPA proposed action, 7-10 production structures are projected in offshore Subareas W0-60 and W60-200. Between 4 and 6 structure removals using explosives are projected for the W0-60 subarea and 1 is projected in Subarea W60-200. The explosive removals of platforms should not impact the biota of topographic features because the Topographic Features Stipulation prohibits the emplacement of platforms within 152 m (500 ft) of the No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

Effects of the Proposed Action without the Proposed Stipulation

The topographic features and associated coral reef biota of the Western Gulf could be adversely impacted by oil and gas activities resulting from a proposed action in the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected Western Gulf topographic features.

The No Activity Zone would probably be the area of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Feature Stipulation and not followed up by mitigating measures. These impacting activities could include vessel anchoring and infrastructure emplacement, discharges of drilling muds and cuttings, and ultimately the explosive removal of structures. All the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Such activities would physically and mechanically alter benthic substrates and their associated biota over areas possibly ranging from tens to thousands of square meters per impact. Operational discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and interfering with larval settlement, resulting in the decrease of live benthic cover.

Finally, the unrestricted use of explosives to remove platforms installed in the vicinity of or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms caused by depositing foreign substances onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the 1,000-Meter Zone, 1-Mile Zone, and 4-Mile Zone would definitely impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations within the 3-Mile Zone would be a further source of impact to the sensitive biological resources of the topographic features.

Therefore, in the absence of the Topographic Features Stipulation, a proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.2.1.1.4.2. Continental Slope and Deepwater Resources

4.2.1.1.4.2.1. Chemosynthetic Deepwater Benthic Communities

Physical

The greatest potential for adverse impacts on deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (**Chapter 4.1.1.3.8.1**), anchoring (**Chapter 4.1.1.3.3.1**), and structure emplacement (**Chapter 4.1.1.3.3**), as well as from an accidental seafloor blowout (**Chapter 4.4.4.2.1**). Potential impacts from blowouts are discussed in **Chapter 4.4.4.2.1**. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area.

Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. The presence of a conventional structure can also cause scouring of the surficial sediments by near-bottom ocean currents (Caillouet et al., 1981), although this phenomenon has not been demonstrated around structures in deep water.

Anchors from support boats and ships (or any buoys set out to moor vessels), floating drilling units, barges used for construction of platform structures, pipelaying vessels, and pipeline repair vessels also cause severe disturbances to small areas of the seafloor. The areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variety of prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy chemosynthetic communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the floating central drilling structure.

Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared to operations on the shelf.

Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. Many oil and gas support operations involving ships and boats would not result in anchor impacts on deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or mooring buoys. In addition, there are drillships, construction barges, and pipelaying vessels operating in the Gulf of Mexico that rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and water currents. New technologies, such as suction pile anchors, could also limit the area impacted by the anchors themselves. Anchoring will likely destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for substrate as well as dispersion of hydrocarbon sources. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities.

Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha (0.79 ac) of bottom is disturbed per kilometer of pipeline installed). Since pipeline systems are not as established in deepwater as in shallow water, new installations are required, which will tie into existing systems or bring production directly to shore. Pipelines will also be required to transport product from subsea systems to fixed platforms.

In addition to physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cutting discussed below. In deep water, the probability that infrastructure will be left on the seabed is likely higher. As one example, the ConocoPhillips Joliet platform was the first TLP in the GOM and was installed in 1986 at a depth of 537 m (1,762 ft) in Green Canyon Block 184. The subsea template will be left in place after severing the tendons connecting the floating structure. This option will virtually eliminate all bottom-disturbing impacts. The well-studied Bush Hill is located only about 1.26 nmi (2.33 km) from the TLP bottom template.

The impacts from bottom-disturbing activities directly on chemosynthetic communities are expected to be extremely rare because of the application of protective measures required by NTL 2000-G20. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering.

Discharges

In deep water, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Some information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m has been reported by Gallaway and Beaubien (1997). In this instance, a veneer of cuttings was observed scattered over the bottom, in some cases as thick as 20-25 cm (8-10 in). Chemical evidence of SBF components (used during this operation) was found at distances of at least 100 m (328 ft) from the well site (sampling distance was limited by the ROV tether length). Other information from a geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m (1,312 ft) water depths (Nunez, personal communication, 1994). At these sites, the areal coverage of cuttings was found extending from the previous well locations in splay or finger-like projections to a maximum of about 610 m, with an average of about 450 m (1,476 ft). An examination of side-scan-sonar records of these splays indicates that they were distributed in accumulations less than 30 cm (12 in) thick.

A major new deepwater effects study funded by MMS was completed in 2006, *Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico* (CSA, 2006). This project included determinations of the extent of muds and cuttings accumulations resulting from both exploratory and development drilling at three sites in approximately 1,000 m (3,281 ft) of water. Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within the 500-m (1,640-ft) radius of what was termed near-field stations. A combination of a smooth seafloor (little backscatter on sidescan-sonar records) and a high amplitude response at the seafloor on high-resolution subbottom profiles was used to identify areas of probable drilling mud deposition. Areas where sidescan-sonar showed high reflectivity extending in a radial pattern around the well sites were interpreted as cuttings. Generally, areas mapped as drilling muds were identified within about 100 m (328 ft) of well sites. Areas mapped as cuttings typically extended several hundred meters from well sites, with the greatest distance of about 1 km (0.6 mi) observed at two study sites. Geophysically mapped cuttings zones ranged from 13 to 109 ha (32 to 269 ac) in area, with larger zones observed at post-development sites.

Discretionary samples taken in likely mud/cuttings areas provided information about the thickness of mud and cuttings at a few stations. Sediment cores indicated accumulations of 2-4 cm (1-2 in) using concentrations of barium, total organic carbon and Lead 210 ($_{210}$Pb). Impacts from muds and cuttings are also expected from two additional sources: (1) initial well drilling and installation of casing prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various dual-gradient or subsea mudlift drilling techniques in the deep sea. Pre-riser casing installation typically involves 36-in (91-cm) casing that may be set to a depth of 300 ft (91 m) and 26-in (66-cm) casing that may be set to a depth of 1,600 ft (488 m). Jetted or drilled cuttings from the initial wellbore could total as much as 226 m^3 (Halliburton Company, 1995). With dual-gradient drilling techniques, the upper portion of the wellbore will be "drilled" similar to conventional well initiation techniques with cuttings being discharged at the seafloor. After the BOP stack is installed, subsea mudlift pumps will circulate the drilling fluid and cuttings to the surface for conventional well solids control. Discharges from the dual-gradient drilling operations are expected to be similar to conventional drilling operations. Although the full areal extent and depth of burial from these initial activities are not known, the potential impacts are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

MacDonald et al. (1995) indicates that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube-worm and mussel communities may be more vulnerable than clam communities because clam communities are vertically mobile (preventing burial) and sparsely distributed. The primary concern related to muds and cuttings discharges is that of burial. Although chemosynthetic organisms thrive with some part of their anatomy located next to or inside of toxic and/or anoxic environments, all chemosynthetic megafauna (also including their symbiotic bacteria) also require oxygen to live. Complete burial by sediments or rock fragments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms (motile clams being one possible exception). Depending on the organism type, just a few centimeters of burial could cause mortality.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. Detrimental effects because of burial are expected to decrease exponentially in the same manner that the depths of discharge accumulations decrease exponentially with distance from the origin. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. With the application of NTL 2000-G20, it is expected that no chemosynthetic communities would be located closer than 1,500 ft (457 m) from the surface location of any muds or cuttings discharges.

High-density, Bush Hill-type communities are areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long time intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. A long span of time is required for the precipitation of enough carbonate rock to support a large population of tube worms. As dense tube-worm communities require hard substrate as well as very active seepage at any point in space, existing communities covered by sediment that are physically damaged would likely never recover (Fisher, 1995).

Information is limited about the vulnerability of tube worms to sedimentation/smothering impact. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably, this burial occurs over long time intervals and may, in large part, be actual growth of the tube worm "root" into sediments in order to obtain required sulfide for the symbiotic bacteria's metabolism. Evidence of catastrophic burial of high-diversity chemosynthetic communities can be found in the paleorecord as documented by Powell (1995), but the importance of this in causing local extinctions was reported as minor. These burials were probably caused by catastrophic seismic events.

Methanotrophic mussel communities have strict chemical requirements that tie them directly to areas of the most active seepage. Physical disturbance of an active mussel bed is thought not to have a long-lasting effect on the community due to high growth rates of individuals (Fisher, 1995). Catastrophic mud burial would be one possible cause of a mussel community death. It is predicted that a mussel community completely eliminated by physical disturbance could be resettled and mature within 20 years.

Effluents from routine OCS operations (not muds or cuttings) in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m (328 ft).

Reservoir Depletion

There has been some speculation about the potential impact to chemosynthetic communities as a result of oil and gas withdrawal, causing a depletion of the energy source (hydrocarbons) sustaining the chemosynthetic organisms. There is evidence that both removal and reinjection of material into reservoirs that supply seeps on land in California affect the seepage rates. Quigley et al. (1996) reported evidence that suggested offshore California oil production resulted in reduced seepage due to reduction in reservoir pressure. The seeps and faults around which chemosynthetic animals live are supplied from the deep reservoirs that transport the gas or oil to the seafloor through combined effects of buoyancy and pressure. When all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 30% or less of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (less likely) stop.

Based on current information, it is not possible to determine whether reduced reservoir pressure would actually reduce the seepage (as observed onshore) or whether there may be enough oil already in the conduit to the surface to continue adequate levels of seepage for long periods, perhaps thousands of years or more. In the case of the well-studied Bush Hill community in Green Canyon Block 184, there has been no detectable change in community composition resulting from extraction of the hydrocarbon reserves by the nearby ConocoPhillips Joliet production field over the last 20 years. The Jolliet platform is scheduled to be removed in the near future, after having extracted all economically recoverable hydrocarbons from the same source location that is connected to the Bush Hill community. The distribution of chemosynthetic communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients in either the near or distant future may potentially impact the type and distribution of the associated biological community.

Proposed Action Analysis

Because high-density chemosynthetic communities are generally found only in water depths greater than 400 m (1,312 ft), they would not be found in shallow-water areas of the WPA (Subareas W0-60, W60-200, or W200-400; **Table 4-2**). Chemosynthetic communities could be found in the deeper water areas (Subareas W400-800, W800-1600, W1600-2400, and W>2400; **Table 4-2**). Of the 60+ known communities, only a few of these chemosynthetic communities are known to exist in the WPA (**Figure 3-9**). However, the deepest known hydrocarbon seep communities (not Florida escarpment) have been discovered in the WPA's Alaminos Canyon area, with the deepest to date at around 2,750 m in Alaminos Canyon Block 818. The levels of projected impact-producing factors for deepwater Subareas W400-800, W800-1600, W1600-2400, and W>2400 are shown in **Table 4-2**. A range of 4-7 oil and gas production structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2007 and 2046 in the deepwater portions of the WPA as a result of a proposed action. These deepwater production structures are expected to be installed beginning in the third year and continue throughout the analysis period.

Notice to Lessees (NTL) 2000-G20 has been a measure for the protection of chemosynthetic communities since February 1, 1989. Now, NTL 2000-G20 makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NTL is exercised on all applicable leases and is not an optional protective measure. Under the provisions of this NTL, lessees operating in water depths greater than 400 m (1,312 ft) are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities; if such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities of the Bush Hill type. Requirements for specific separation distance between potential high-density chemosynthetic communities and both anchors (250-500 ft) and drilling discharge points (1,500 ft) have been included in the newest revision of the NTL. If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place in the area; if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid any areas that show the potential to support chemosynthetic communities. The basic assumptions underlying the provisions of this mitigation measure are (1) that dense chemosynthetic communities are associated with gas-charged sediments and oil or gas seeps, (2) that the gas-charged sediment zones or seeps have physical characteristics that will allow them to be identified by geophysical surveys, and (3) that dense chemosynthetic communities are not found in areas where gas-charged sediments or seeps are not indicated on the geophysical survey data. These assumptions have not been totally verified. A definitive correlation between the geophysical characteristics recorded by geophysical surveys and the presence of chemosynthetic communities has not been proven; however, the associations have proven to be very reliable in most all situations encountered to date, particularly on the upper continental slope.

Although there are limited examples of field verification, the requirements set forth in NTL 2000-G20 are considered effective in identifying potential areas of chemosynthetic communities. Although there has generally been compliance with NTL 2000-G20, compliance does not guarantee avoidance of high-density communities without visual confirmation in every case. On rare occasions, high-density chemosynthetic community areas may not be properly identified using the geophysical remote sensing and indicators specified in the existing NTL. The reliability of correlation between remote-sensing signatures and the presence of high-density communities may be reduced or different on the lower slope of the GOM. A new major study, which will specifically investigate this concern, is beginning at the time of this writing (May 2006). Funded by both MMS and NOAA's Office of Ocean Exploration, this 4- year project will explore for and study chemosynthetic communities located deeper than 1,000 m (3,281 ft). As new information becomes available, the NTL will be further modified as necessary.

High-density, Bush Hill-type communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 2000-G20. A limited number of these communities have been found to date, but it is very probable that many additional communities exist. Observations of the surface expression of seeps from space images indicate numerous other communities may exist (MacDonald et al., 1993 and 1996). Most chemosynthetic communities are of low density and are relatively widespread throughout the deepwater areas of the Gulf. Physical disturbance or destruction of a small, low-density area would not result in a major impact to chemosynthetic communities as an ecosystem. Low-density communities may occasionally sustain impacts from discharges of drill muds and cuttings, bottom-disturbing activities, or resuspended sediments. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans). In light of probable avoidance of all chemosynthetic communities (not just high-diversity types) as required by NTL 2000-G20, the frequency of such impact is expected to be very low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos. Recolonization after a disturbance would not exactly reproduce the preexisting community prior to the impact, but it could be expected that some similar pattern and species composition would eventually reestablish if similar conditions of sulfide or methane seepage persist after the disturbance.

Summary and Conclusion

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment in the same locations.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience very minor (if any) impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

4.2.1.1.4.2.2. Nonchemosynthetic Deepwater Benthic Communities

Physical

Benthic communities other than chemosynthetic organisms could be impacted by OCS-related bottom-disturbing activities associated with pipelaying (**Chapter 4.1.1.3.8.1**), anchoring (**Chapter 4.1.1.3.3.1**), and structure emplacement (**Chapter 4.1.1.3.3**), as well as from a seafloor blowout (**Chapter 4.4.2.2**). Potential impacts from blowouts are discussed in **Chapter 4.4.4.2.2**. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage can be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. These impacts are the same as those encountered in shallower continental shelf waters.

Anchors from support boats and ships (or from any buoys set out to moor vessels), floating drilling units, pipelaying vessels, and pipeline repair vessels also cause severe disturbances to small areas of the seafloor with the areal extent related to the size of the mooring anchor and length of chain that would rest on the bottom. Excessive scope (length) and movement of the mooring chain could disturb a much larger area of the bottom than would an anchor alone, depending on the prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could impact communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the floating central drilling structure. Larger anchors and additional scope of anchor chain are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. The use of other anchoring technologies such as suction pile anchors would reduce the impacted area. The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. (Many OCS-support operations and activities will not result in anchor impacts to deepwater benthic communities because vessels will tie-up directly to rigs, platforms, or mooring buoys or will use dynamic positioning). Anchoring will not necessarily directly destroy small infaunal organisms living within the sediment; the bottom disturbance would most likely change the environment to such an extent that the majority of the directly impacted infauna community would not survive (e.g., burial or relocation to sediment layers without sufficient oxygen). In cases of carbonate outcrops or reefs with attached epifauna or coral, the impacted area of disturbance may be small in absolute terms, but it could be large in relation to the area inhabited by fragile hard corals or other organisms that rely on exposed hard substrate.

As described in the previous section for chemosynthetic communities, normal pipelaying activities in deepwater areas could destroy large areas of benthic communities (it is assumed that 0.32 ha (0.79 ac) of bottom is disturbed per kilometer of pipeline installed.); although, without consideration of chemosynthetic organisms, there are no differences between this activity in deep water as compared to shallow-water operations below 200 ft where pipeline burial is not required.

In addition to direct physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below.

Discharges

In deep water, discharges of drilling muds and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. As detailed in the previous **Chapter 4.2.1.1.4.1.1**, some information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m has been reported by Gallaway and Beaubien (1997) as well as a major new study looking at both exploratory and production drilling in water depths of 1,000 m (3,281 ft) (CSA, 2006). The latter study found drilling mud accumulations ranging up to several hundred meters away from wells in thickness ranging from 2-4 cm (1-2 in).

Impact from muds and cuttings are also expected from two additional sources: (1) initial well drilling prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various riserless drilling techniques in the deep sea. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Company, 1995). In the case of some riserless drilling practices, all muds and cuttings from well spudding through total depth would be discharged at the seafloor. Although the full areal extent and depth of burial from these activities is not known, the potential impacts are expected to be localized and short term. Since these areas would occupy only a minuscule portion of the available seafloor in the deepwater GOM, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

Burial by sediments or rock fragments originating from drilling muds and cuttings discharges could smother and kill almost all community components of benthic organisms, with the exception of highly motile fish and possibly some crustaceans such as shrimp capable of moving away from the impacted area. Depending on the organism type, just a few centimeters of burial could cause death. The damage would be both mechanical and toxicological. Some types of macrofauna could burrow through gradual accumulations of overlying sediments depending on the toxicological effects of those added materials. Information on the potential toxic effects on various benthic organisms is limited and essentially nonexistent for deepwater taxa.

It can be expected that detrimental effects due to burial would decrease exponentially with distance from the origin. The physical properties of the naturally occurring surface sediment (grain size, porosity, and pore water) could also be changed as a result of discharges such that recolonizing benthic organisms would be comprised of different species than inhabited the area previous to the impact. Although the impacts could be considered severe to the nonmotile benthos in the immediate area affected, they would be considered very temporary. Because of the proximity of undisturbed bottom with similar populations of benthic organisms ranging in size from microbenthos to megafauna, these impacts would be very localized and reversible at the population level and are not considered significant.

Carbonate outcrops and deepwater coral communities not associated with chemosynthetic communities, such as the deepwater coral "reef" or habitat first reported by Moore and Bullis (1960) and later by Schroeder (2002), are considered to be most at risk from oil and gas operations. No significant deepwater coral communities have been discovered in the WPA to date. Because deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover. However, the principal habitat-forming coral taxa, *Lophelia*, at the best developed site in Viosca Knoll Block 826 does form structures with some relief that would be more resistant to any conceivable thickness of drill cuttings. Burial of previously exposed hard substrate would prevent future recolonization until some event that excavated the substrate again.

Effluents other than muds or cuttings from routine OCS operations in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m (328 ft).

Proposed Action Analysis

For a proposed action in the WPA, 4-7 oil and gas structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2007 and 2046 in offshore subareas W400-800, W800-1600, W1600-2400, and W>2400 (**Table 4-2**, **Figure 4-1**). These deepwater production structures are expected to be installed beginning in the third year and will continue throughout the analysis period. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Surface discharge of muds and cuttings, as opposed to seafloor discharge, would reduce or eliminate the impact of smothering the benthic communities on the bottom.

Under the current review procedures for chemosynthetic communities, carbonate outcrops are targeted as one possible indication (surface anomaly on 3D seismic survey data) that chemosynthetic seep communities could be nearby. Unique communities that may be associated with any carbonate outcrops or other topographical features could be identified via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a geological hazard for any well sites. Any proposed activity in water depth greater than 400 m (1,312 ft) would automatically trigger the NTL 2000-G20 evaluation described above.

Summary and Conclusion

Some impact to soft-bottom benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic infaunal communities occurred, recolonization from populations from neighboring soft bottom substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be relatively rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities. Impacts to other hard bottom communities are expected to be avoided as a consequence of the application of the existing NTL 2000-G20 for chemosynthetic communities. The same geophysical conditions associated with the potential presence of chemosynthetic communities also results in hard carbonate substrate that is generally avoided.

4.2.1.1.5. Impacts on Marine Mammals

Potential effects on marine mammal species may occur from routine OCS activities and may be direct or indirect. The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and marine debris from service vessels and OCS structures.

Discharges

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced sand and well treatment, workover, and completion fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater. The USEPA, through general permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities.

Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (Neff et al., 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Trace metals, including mercury, in drilling discharges have been a particular concern. However, Neff et al. (1989) concluded that metals associated with drilling fluid were virtually nonbioavailable to marine organisms. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from stranded GOM bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (Neff et al., 1989). Adequate baseline data is not available to determine the significant sources of contaminants that accumulate in Gulf cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the GOM from a variety of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. Coastal cetacean species tend to have higher levels of metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al,. 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow water than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft between platforms.

Marine mammals often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as species, the activity the animals are engaged in, and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters or those with calves sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occurs. Absence of conspicuous responses to an aircraft does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitations, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladed vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). Noise could disturb marine mammals in the immediate vicinity of a service vessel; however, this effect would be limited in area and duration.

Worldwide records of vessel collisions with sperm whales are fairly common (Laist et al, 2001). Records of vessel collisions with Bryde's whales (considered rare in the GOM; the only regularly occurring baleen whale in the GOM) are rare. Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales and that (1) the majority of collisions appear to occur over or near the continental shelf, (2) most lethal or severe injuries are caused by ships 80 m or longer, (3) whales usually are not seen beforehand or are seen too late to be avoided, and (4) most lethal or severe injuries involve ships traveling 14 kn or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001).

Increased traffic from support vessels involved in survey, service, or shuttle functions will increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared with control periods (no boats present within 100 m (328 ft)) in a study conducted in Sarasota Bay, Florida. They also found that dolphins' decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or growth, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the leased sites could affect them. Fertl et al. (2005) found manatees to be most common in estuarine and river mouth habitats and rare in the open ocean. A manatee present where there is vessel traffic could be injured or killed by a vessel strike (Wright et al., 1995). In 1995, an oil crew workboat struck and killed a manatee in a canal near coastal Louisiana (Fertl et al., 2005). Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to detect effectively boat noise and avoid collisions with boats (Gerstein et al., 1999).

Drilling and Production Noise

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Toothed whales use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994). This throws doubt on the assumed insensitivity of toothed whale hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many industrial sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). As many OCS-industry sounds are concentrated at low frequencies, there is particular concern for baleen whales as they are apparently more dependent on low-frequency sounds than are other marine mammals. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. The response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but marine mammals may be affected by noise in difficult-to-observe ways. For example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause behavioral changes that affect feed intake, social interactions, or parenting. All of these effects might eventually result in population declines (Bowles, 1995).

Structure Removals

A limited amount of information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998). The shock wave produced by explosions can cause physical damage to nearby animals. The potential for injury is associated with gas-containing internal organs, such as the lungs and intestines (Yelverton et al., 1973). Data are limited regarding blast-induced auditory damage. Explosions and shock waves and their intense transient sound field have the ability to produce blast injury and acoustic trauma in marine mammals (Ketten, 1995 and 1998). Consequences of hearing damage may range from subtle modification of certain behaviors to acute, where concussive effects may lead to death (Ketten, 1995).

For example, two humpback whales were found with damage to their ear bones following an explosion in Newfoundland (Ketten et al., 1993). Yet other humpback whales in Newfoundland, foraging in an area of explosive activity, showed little behavioral reaction to the detonations in terms of decreased residency, overall movements, or general behavior, although orientation ability appeared to be affected (Todd et al., 1996). Todd et al. (1996) suggested caution in interpretation of the lack of visible reactions as indication that whales are not affected or harmed by an intense acoustic stimulus; both long- and short-term behavior as well as anatomical evidence should be examined. The researchers interpreted increased entrapment rate of humpback whales in nets as the whales being influenced by the long-term effects of exposure to deleterious levels of sound.

Toothed whales cannot hear well in the frequencies emitted by explosive detonations (Richardson et al., 1995). The animals may not be able to hear the pulse generated from open-water detonations of explosive charges because it is very brief (*Federal Register*, 1995a). Sublethal effects would include a startle response. Even if dolphins are not capable of hearing the acoustic signature of the explosion, physiological, pathological, or behavioral responses to detonations may still result. The NOAA Fisheries Service (USDOC, NMFS, 1995) cites such examples as detection of low-frequency sound by some mechanism other than conventional hearing and harassment due to tactile stings from the shock wave accompanying detonations. Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995b). Because of its temporary effect, no impacts to higher life forms are expected, and, because of its temporary and localized nature, biomagnification is unlikely.

The extent of potential injury is dependent upon the amount of explosive used, distance from the charge, and body mass of the cetacean. There is no evidence linking dolphin injuries or deaths in the GOM to explosive removal of structures (Klima et al., 1988; Gitschlag et al., 1997). In October 1995, NOAA Fisheries Service issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of gas drilling and production structures in State waters and on the GOM OCS for a period of five years (*Federal Register*, 1995b). The NOAA Fisheries Service is currently in the final stages of completing rulemaking under the MMPA, and the associated ESA consultation, for explosive removal of structures in the GOM.

In order to minimize the likelihood of injury to marine mammals from explosive structure removals, MMS has issued guidelines (NTL 2004-G06) to offshore operators. These guidelines specify (1) explosive removals only during daylight hours, (2) staggered detonation of explosive charges, (3) placement of charges 5 m (15 ft) below the seafloor, and (4) pre- and post-detonation aerial surveys within 1 hour before and after detonation. Trained observers watch for sea turtles and marine mammals in the vicinity of the structures to be removed.

Seismic Surveys

The MMS completed a programmatic EA on G&G permit activities in the GOM (USDOI, MMS, 2004) and is currently in consultation with NOAA Fisheries Service for rulemaking under the MMPA and the associated ESA procedure. The PEA includes a detailed description of the seismic surveying technologies, energy output, and operations. This document is hereby incorporated by reference. Seismic surveys use a high-energy noise source. During Irish Sea seismic surveys, pulses were audible on hydrophone recordings above the highly elevated background ship noise at least up to the 20-km (12-mi) range (Goold and Fish, 1998). Although the output of airgun arrays is usually tuned to concentrate low-frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish, 1998). These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and extend well into the ultrasonic range up to 50 kHz.

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km (4-5 mi) of an airgun array. Humpback whales off western Australia were found to change course at 3-6 km (2-4 mi) from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (McCauley et al., 1998a and b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km (4-7 mi) from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). For baleen whales, in particular, it is not known whether (1) the same individuals return to areas of previous seismic exposure, (2) seismic work has caused local changes in distribution or migration routes, or (3) whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). Individually identified gray whales remained in Puget Sound long after the seismic survey (as is typical), despite being exposed to noise (Calambokidis and Osmek, 1998; Bain et al., 1999).

Goold (1996) found that acoustic contacts with common dolphins in the Irish Sea dropped sharply as soon as seismic activity began, suggesting a localized disturbance of dolphins. Given the high, broadband seismic-pulse power levels across the entire recorded bandwidth and the known auditory thresholds for several dolphin species, Goold and Fish (1998) considered such seismic emissions to be clearly audible to dolphins across a bandwidth of tens of kilohertz and at least out to the 8-km (5-mi) range. No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out during a 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observable behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996).

Results of passive acoustic surveys to monitor sperm whale vocal behavior and distribution in relation to seismic surveys in the northeast Atlantic revealed few, if any, effects of airgun noise (Swift et al., 1999). The authors suggested that sperm whales in that area may be habituated to seismic surveys and/or responses may occur at scales to which the research was not sensitive. Sperm whales during the Heard Island Feasibility Test were found to cease calling during some (but not all) times when seismic pulses were received from an airgun array >300 km (<186 mi) away (Bowles et al., 1994). In contrast, sperm whales in the Gulf were frequently heard vocalizing while seismic pulses were ongoing. It is unclear whether the well-documented, continued occurrence of sperm whales in the area off the mouth of the Mississippi River is a consequence of low sensitivity to seismic sound or a high motivation to remain in the area. Sperm whales have historically occupied this area, and their continued presence might suggest habituation to the seismic signals. During the MMS-sponsored GulfCet II study on marine mammals, results showed that the cetacean sighting rate did not change significantly because of seismic exploration signals (Davis et al., 2000). The analysis of the results was unable to detect small-scale (<100 km, <62 mi) changes in cetacean distribution.

Since the last multisale EIS, MMS conducted annual research cruises under the Sperm Whale Seismic Study (SWSS) program through 2005. The final year, 2006, is being devoted to data analysis and the publication of a synthesis report, including the various facets of SWSS. A detailed report of the research conducted from 2002 through 2004 has been published (Jochens et al., 2005). Experiments were designed to investigate the sound exposure level at which behavioral changes began to occur. The primary tool for this investigation was the D-tag used in conjunction with seismic airgun controlled exposure experiments (CEE's) to quantify changes in the behavior of sperm whales throughout their dive cycle. Eight whales were tagged over two field seasons (2002-2003). The acoustic exposure and foraging behavior of these whales were recorded on the D-tag before, during, and after a 1- to 2-hr controlled sound exposure to typical airgun arrays. The maximum sound level exposures for the eight whales were between 130 and at least 162 dBp-p re 1 μPa at ranges of 1.5-12.8 km (0.9-8.0 mi) from the sound source.

The whales showed no change to diving behavior or direction of movement during the gradual ramp-up or during the full-power sound exposures. There was no avoidance behavior toward the sound source. Foraging behavior was temporarily altered for the whale that was approached most closely. The surface resting period was prolonged hours longer than typical, but normal foraging behavior resumed immediately after the airguns ceased. The increased surface period may be a type of vertical avoidance to the sound source as the received sound level at the surface is expected to be less than farther down in the water column. There was a decrease of "buzzes" (distinctive echolocation sounds thought to be produced by sperm whales during prey capture attempts) in the foraging dives of the other exposed whales when compared with those of unexposed whales; however, the decrease was not statistically significant. Other analyses applied to these results led the researchers to suggest that a 20 percent decrease in foraging attempts at exposure levels ranging from <130 to 162 dBp-p re 1 μPa at distances of roughly 1-12 km (0.6-8 mi) from the sound source is more likely than no effect.

Whale locations from S-tags were compared with positions of active seismic vessels to determine whether tagged whales occurred less frequently than expected in areas of active seismic surveys in the GOM (potential vessel avoidance behavior). Chi-square testing and Monte Carlo simulations revealed no evidence that the data (whale locations) were nonrandomly distributed. However, the researchers caution that this apparent lack of avoidance to the seismic vessels is based on a very small sample size and cannot be used to refute a possible behavioral response. The sperm whale sightings of the visual team aboard the *Gyre* were also analyzed to investigate medium-term responses of whales to seismic surveys occurring in the area. No significant responses were observed in (1) the heading relative to the bearing to seismic surveys, (2) time spent at the surface, or (3) surfacing rate in the comparisons of matched pairs 2 hours before and 2 hours after line starts and line ends for survey lines within 100, 50, or 25 mi.

The results of these three independent approaches suggest that sperm whales display no horizontal avoidance to seismic surveys in the GOM. However, these observations are based on very few exposures <160 dBp-p re 1 µPa. Also, these experiments were carried out in an area with substantial human activity and the whales are not naive to human-generated sounds.

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given the transitory nature of seismic exploration, the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals, and the avoidance responses that occur in at least some baleen whales, when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Marine Debris

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and the Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and ingestion of, or entanglement in, discarded material could injure or kill cetaceans.

Proposed Action Analysis

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and human-generated debris from service vessels and OCS structures.

Some industry-generated effluents are routinely discharged into offshore marine waters. Marine mammals may have some interaction with these discharges. Indirect effects to marine mammals through prey exposure to discharges are expected to be sublethal. Because OCS discharges are diluted and dispersed in the offshore environment, direct impacts to marine mammals are expected to be negligible.

Helicopter operations (take-off and landings) projected for a proposed action in the WPA are 400,000-900,000 operations (**Table 4-2**) over the life of a proposed action. This equates to an average annual rate of 10,000-22,500 operations. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. In addition, guidelines and regulations issued by NOAA Fisheries Service under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that marine mammals would be affected by routine OCS helicopter traffic operating at these altitudes. It is expected that about 10 percent of helicopter operations would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from and interrupt marine mammals nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on marine mammals; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions such as feeding and breeding. Temporary disturbance to marine mammals may occur as helicopters approach or depart OCS facilities if animals are near the facility. Such disturbance is believed negligible.

Service-vessel round trips projected for a proposed action in the WPA are 94,000-155,000 trips (**Table 4-2**) over the life of a proposed action. This equates to an average annual rate of 2,350-3,875 trips. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from marine mammals or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. Bejder et al. (2005) found that bottlenose dolphins per km^2 significantly declined with increasing tour operators. These were long-term impacts that had not been noticed when earlier studies had emphasized short-term behavioral responses. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Dolphins may approach vessels that are in transit to bow-ride. Manatees are known to have been killed by vessel strikes (e.g., Schiro et al., 1998), and most manatees bear prop scars from contact with vessels. However, manatees are rare in the Western and Central Gulf and consequently, OCS vessel traffic should pose little risk to that endangered species. The rapid increase in exploration and development of petroleum resources in deep oceanic waters of the northern Gulf has increased the risk of OCS vessel collisions with sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales may be more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. The MMS has issued regulations and guidelines to minimize the chance of vessel strike to marine mammals with proposed protected species lease stipulations and NTL 2003-G10, “Vessel Strike Avoidance and Injured/Dead Protected Species Reporting.”

A total of 42-66 exploration and delineation wells and 155-221 development wells are projected to be drilled as a result of a proposed action in the WPA. A total of 28-41 platforms are projected to be installed as a result of a proposed action. These wells and platforms could produce sounds at intensities and frequencies that could be heard by marine mammals. It is expected that noise from drilling activities would be relatively constant during the temporary duration of drilling. Toothed whales echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms (Gales, 1982). Bottlenose dolphins, one of the few species in which low-frequency sound detection ability has been studied, have poor sensitivity at the level where most OCS-industry noise energy is concentrated. Baleen whales are apparently more dependent on low-frequency sounds than other marine mammals and may be species of concern regarding OCS-industry noise. However, all baleen whale species, except for the Bryde’s whale, are considered extralimital or accidental in the GOM. Bryde’s whales are considered rare in the Gulf and observations of this species have been almost exclusively in the Eastern GOM (Davis et al., 2000). Thus, Bryde’s whales and other baleen whale species are not likely to be subjected to OCS drilling and production noise. Potential effects on GOM marine mammals include disturbance (i.e., subtle changes in behavior, interruption of previous activities, or short- or long-term displacement), masking of natural sounds (e.g., surf and predators) and calls from conspecifics, stress (physiological), and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of a noninjurous physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. It is estimated that 11-17 production structures resulting from a proposed action will be removed using explosives. It is expected that structure removals will cause only minor behavioral changes and noninjurious physiological effects on marine mammals as a result of the implementation of MMS NTL guidelines and regulations, and the NOAA Fisheries Service Observer Program for explosive removals. To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures.

Many types of materials, including plastics, are used during drilling and production operations. Some of this material is accidentally lost overboard where marine mammals could consume it or become entangled in it. The result of ingesting some materials lost overboard could cause disease or death. Entanglement is a concern, as some packaging materials may be of a size and/or shape that could be impossible for a marine mammals to jettison. Many of the plastics used by industry could withstand years of saltwater exposure without disintegrating or dissolving. An entangled marine mammal may suffer from acute impaired mobility that compromises its health quickly, or it may decline slowly from diminishing feeding and reproductive capability. The increased energy required to overcome the handicap of entanglement may require more food than the entangled whale can capture. Industry directives for reducing marine debris and MMS's guidelines through its NTL for maintaining awareness of the problem and eliminating accidental loss continue to minimize industry-related trash in the marine environment.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by a chance collision with a service vessel; however, current MMS requirements and guidelines for vessel operation in the vicinity of protected species should minimize this risk (i.e., the proposed Protected Species Lease Stipulation and NTL 2003-G10).

Marine mammal ingestion of industry-generated debris is a concern. Sperm whales may be particularly at risk because of their suspected feeding behavior involving cruising along the bottom with their mouth open. Entanglement in debris could have serious consequences. A sperm whale could suffer diminished feeding and reproductive success, and potential injury, infection, and death from entanglement in discarded packing materials or debris. Industry has made good progress in debris management on vessels and offshore structures in the last several years. The debris awareness training, instruction, and placards required by the proposed Protected Species Lease Stipulation and NTL 2003-G11 should greatly minimize the amount of debris that is accidentally lost overboard by offshore personnel.

There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Noise associated with a proposed action, including drilling noise, aircraft, and vessels, may affect marine mammals by eliciting a startle response or masking other sounds. However, many of the industry-related sounds are believed to be out of, or on the limits of, marine mammal hearing, and the sounds are also generally temporary. The continued presence of sperm whales in close proximity to some of the deepwater structures in the GOM tends to rule out concerns of permanent displacement from disturbance.

Seismic operations have the potential to harm marine mammals in close proximity to firing airgun arrays. The proposed protected species lease stipulations and the several mitigations, including onboard observers and airgun shut-downs for whales in the exclusion zone, included in NTL 2004-G01 ("Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program") minimize the potential of harm from seismic operations to marine mammals.

Marine mammal death or injury is not expected from explosive structure removal operations. Existing mitigations and those recently developed for structures placed in oceanic waters should continue to minimize adverse effects to marine mammals from these activities.

Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification. Although the scope and magnitude of such effects are not known, direct or indirect effects are not expected to be lethal.

Routine activities related to a proposed action, particularly when mitigated as required by MMS, are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population endemic to the northern GOM.

4.2.1.1.6. Impacts on Sea Turtles

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational contaminant discharges; noise from seismic exploration, helicopter and vessel traffic, operating platforms, and drillships; vessel collisions; explosive platform removals; and OCS-related trash and debris.

Contaminants and Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by USEPA NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web. Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling mud. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the GOM carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights; however, anecdotal reports indicate that sea turtles often react to the sound and/or the shadow of an aircraft by diving. It is assumed that aircraft noise can be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided because of noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sound responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been observed noticeably increasing their swimming in response to an operating seismic source at 166 dB re-1μPa-m (McCauley et al., 2000). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). Increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel strikes are a cause of sea turtle mortality in the Gulf (Lutcavage et al., 1997). Stranding data for the U.S. Gulf and Atlantic Coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997). Vessel-related injuries were noted in 13 percent of stranded turtles examined from the GOM and the Atlantic during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5-50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles will be impacted.

Explosive Platform Removals

Offshore structures serve as artificial reefs and are sometimes used by sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, green, Kemp's ridley, and hawksbill have also been observed (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). Loggerheads may reside at specific offshore structures for extended periods of time (Rosman et al., 1987b; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987b). Sea turtles probably use platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been observed sleeping under platforms or beside support structures (Hastings et al., 1976; Rosman et al., 1987b; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989 and 1990).

Information about the effects of underwater explosions on sea turtles is limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and suggested that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NOAA Fisheries Service conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, turtles within 3,000 ft of the platform were rendered unconscious (Klima et al., 1988), although they resumed apparently normal activity 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage to the cloacal lining (it was everted) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for three weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed 1 hr. Injured turtles that are capable of swimming may return to the surface, while moribund turtles may sink to the seafloor or drift away from the work site. Unconsciousness renders a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives is two loggerheads during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one loggerhead in 1997 (Gitschlag, personal communication, 1999), one loggerhead in 1998 (Shah, personal communication, 1998), and one loggerhead in 2001 (Gitschlag, personal communication, 2001). A total of six additional sea turtles have been captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). The low number of turtles affected by explosive removal of structures may be because of the few turtles that occur in harm's way at the time explosives are detonated, the effectiveness of the monitoring program established to protect sea turtles, and/or the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), NOAA Fisheries Service initiated an observer program at explosive removals of structures in State and Federal waters of the GOM. For at least 48 hr prior to detonation, NOAA Fisheries Service observers watch for sea turtles at the surface. Helicopter surveys within a 1-mi radius of the removal site are conducted a minimum of 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath structures.

Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments because of explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995b). Because of its temporary effect and localized nature, biomagnification is unlikely.

The MMS petitioned NOAA Fisheries Service for MMPA rulemaking for explosive removal activities in 2004. At present (mid-2006), NOAA Fisheries Service has published the proposed rule. The accompanying ESA consultation and Biological Opinion are close to being final. In preparation for rulemaking, MMS held a mitigation workshop in 2005 to establish suggested explosive removal mitigations that would satisfy NOAA Fisheries Service and that would be feasible for industry.

Marine Debris

A wide variety of trash and debris is commonly observed in the Gulf. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, 40,580 debris items were collected in a 16-mi transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1997). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1997). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open ocean voyage. Some hatchlings spend their "lost years" in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The GOM had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp's ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Effluents are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Information on the contaminants that would be discharged offshore as a result of a proposed action is provided in **Chapter 4.1.1.4**. Turtles may be affected by these discharges. Very little information exists on the impact of drilling muds on Gulf sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in **Chapters 4.2.1.1.3.3 and 4.2.1.1.4.1.1**. The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a proposed action because these sensitive resources are protected by several mitigation measures established by MMS. These mitigation measures include marine protected species NTL's (**Chapter 1.5**).

An estimated 2,350-3,875 service-vessel round trips are expected to occur annually as a result of a proposed action. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter operations are expected to be 10,000-22,500 (take-offs and landings) per year as a result of a proposed action. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles and there is the possibility of short-term disruption of activity patterns. In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

A total of 42-66 exploration wells and 135-192 producing development wells are projected to be drilled as a result of a proposed action. A total of 28-41 platforms are projected to be installed as a result of a proposed action. Of those, 11-17 are projected to be removed with explosives. These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of activity), masking of other sounds (e.g., surf, predators, vessels), and stress (physiological).

Sea turtles can become entangled in or ingest debris produced by exploration and production activities resulting from a proposed action. Leatherback turtles that mistake plastics for jellyfish may be more vulnerable to gastrointestinal blockage than other sea turtle species. The probability of plastic ingestion/entanglement is unknown.

Summary and Conclusion

Routine activities resulting from a proposed action have the potential to harm sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by seismic exploration, helicopter and vessel traffic, platforms, and drillships; vessel collisions; and marine debris generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. Most OCS activities are expected to have sublethal effects.

Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification but there is uncertainty concerning the possible effects. Rapid dilution of the discharges should minimize impact. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas from noise disturbance could cause declines in survival or fecundity, and result in population declines; however, such declines are not expected. The required seismic operation mitigations, particularly clearance of the impact area of sea turtles and marine mammals prior to ramp-up, and the subsequent gradual ramping up of the airguns, should minimize the impact of rapid onset of, and close proximity to, very loud noise. Vessel traffic is a serious threat to sea turtles. Diligence on the part of vessel operators as encouraged by the vessel strike mitigations should minimize vessel/sea turtle collisions. Actual sea turtle impacts from explosive removals in recent years have been small. The updated pre- and post-detonation mitigations should insure that injuries remain extremely rare. Greatly improved handling of waste and trash by industry, along with the annual awareness training required by the marine debris mitigations, is decreasing the plastics in the ocean and minimizing the devastating effects on sea turtles. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the GOM.

4.2.1.1.7. Impacts on Coastal and Marine Birds

This section discusses the possible effects of a proposed action in the WPA on coastal and marine birds of the GOM and its contiguous waters and wetlands. Major, potential impact-producing factors for marine birds in the offshore environment include OCS-related helicopter and service-vessel traffic and noise, air emissions, degradation of water quality, habitat degradation, discarded trash and debris from service-vessels and OCS structures, and structure lighting and presence. Any effects on birds are especially grave for intensively managed populations. For example, endangered and threatened species may be harmed by any impact on viable reproductive population size or disturbance of a few key habitat factors.

Proposed Action Analysis

Noise

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, and boats and a variety of service vessels. It is projected that 400,000-900,000 helicopter operations related to a proposed action in the WPA would occur over the life of a proposed action; this is a rate of 10,000-22,500 annual helicopter operations. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. It is projected that 94,000-155,000 service-vessel round trips related to a proposed action in the WPA would occur in the life of a proposed action; this is a rate of 2,350-3,875 service-vessels trips annually.

Disturbances from OCS-related helicopter or service-vessel traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior. Disturbance can also lead to a permanent desertion of active nests and even whole nest colonies, or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure resulting from nest abandonment. Interruption of nesting activities such as nest building (sensitive to time budgets), foraging for food for nestlings (sensitive to time and energy budgets), and incubation of eggs and naked nestlings (sensitive to time budgets) may result in reduced breeding success, measured by the ratio of birds fledged per nest to eggs hatched from a clutch. Impacts on whole nesting colonies of seabirds would be especially serious. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not reach their destination on schedule or they may be more susceptible to diseases (Anderson, 1995).

Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because aerial predators frequently harass them (Bowles, 1995). The FAA and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds.

The effect of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. However, pilots traditionally have taken great pride in not disturbing birds. Compliance to the specified minimum altitude requirements greatly reduces effects of aircraft disturbance on coastal and marine birds. Routine presence of aircraft at sufficiently high altitudes results in acclamation of birds to routine noise. As a result of inclement weather, about 10 percent of helicopter operations would occur at altitudes somewhat below the minimums listed above. Although these incidents are seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment. Birds in flight over water typically avoid helicopters. Low-flying aircraft may temporarily disrupt feeding or flight paths, including low-altitude foraging trips where birds scan the ground for small prey or scan the water for schools of small pelagic fish. Routine presence and low speeds of service vessels within inland and coastal waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Birds can lose eggs and young when predators attack nests after parents are flushed into flight by service-vessel noise. Overall breeding success (ratio of fledged birds per nest to hatched birds per nest) may be reduced. Chronic effects on breeding are especially serious for endangered or threatened species, because subsequent recovery may not occur.

Air Quality Degradation

Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemic condition, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). Pollutants will accumulate in tissues with unusually low temperatures, low blood content, and low blood flow. Fatty tissues in any organism are especially serious sinks for nonpolar, non-ionic, hydrophobic pollutants. Such pollutants are probably transmitted up the food web without amplification or diminution in concentration. The total amounts transferred up the web probably relate to the total fat content of the components of the food web. Seabirds usually feed in flight and need only resupply moderate protein and fat stores. However, songbirds and shorebirds cannot feed over barriers like the open water of the GOM and need to store up large amounts of fat before flight over them. Such fat stores are especially sensitive to accumulation of hydrophobic contaminants. Top predators on trans-Gulf migrants, such as the breeding peregrine falcons on offshore platforms, are somewhat sensitive to accumulation of such contaminants but the toxins are no threat compared with the historical notorious effects of polychlorinated insecticides on egg-shell thinning in top bird predators such as the bald eagle and peregrine falcon. For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981). Migratory birds may be sensitive because of sustained high ventilation rates required for flight.

Levels of sulfur oxide (mainly sulfur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities are of concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken and results from these studies are not necessarily applicable to wild bird species. Acute exposure of birds to 100 ppm SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH.

Exposure to 100 ppm or less of SO_2 did not affect respiratory mucous secretion. Exposure to 1,000 ppm SO_2 caused mucus to increase and drip from the mouths of birds, but lungs appeared normal. Exposure to 5,000 ppm resulted in gross pathological changes in airways and lungs, and then death (Fedde and Kuhlmann, 1979). Chronic (two week) exposure of birds to three concentrations of SO_2 for 16 hr/day for various total periods showed a statistical change in 10 cellular characteristics and resulted in cellular changes characteristic of persistent bronchitis in 69 percent of the tests done (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980). Accumulation of toxic compounds from such emissions are more probable in birds feeding on terrestrial or aerial prey that breathe air and accumulate contaminants in air of poor quality.

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species will avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties, are also greatly affected by natural factors such as weather and food supply. Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

Chapter 4.2.1.1.1 provides an analysis of the effects of a proposed action in the WPA on air quality. Emissions of pollutants into the atmosphere from the activities associated with a proposed action would have minimum effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates, and pollutant concentrations. Estimated increases in onshore annual average concentrations of NO_2, SO_2, and PM_{10} would be less than 0.42, 0.04, and 0.02 micrograms/m^3, respectively, per modeled steady state concentrations. These concentrations are far below concentrations that could harm coastal and marine birds.

Water Quality Degradation

Chapter 4.2.1.1.1.2 provides an analysis of the effects of a proposed action in the WPA on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Operational discharges or runoff in the offshore environment could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms. These impacts could also be both direct and indirect. Many seabirds feed and nest in the Gulf, so water quality may affect breeding success also (measured as the ratio of fledged birds per nest to hatched birds per nest).

Maintenance dredging operations remove several million cubic feet of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations. Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. A proposed action would result in very small incremental contribution to the need for channel maintenance. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, sublethal physiological stress. Some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Habitat Degradation

Habitat can be described as the physical environment and as the plant substrates used by a bird. The northern GOM and areas inland from it have a large diversity of habitats for birds of all types, including migrants, wintering birds, and breeding birds. The greatest negative impact to coastal and marine birds is loss or degradation of preferred or critical habitat. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Habitat requirements for most bird species are incompletely known. Bird species with similar habitat may crowd each other, depending on amounts of available habitat controlling bird population sizes versus other types of population regulation.

Generally, destruction of wetland habitat from OCS pipeline landfalls and onshore construction may displace localized groups or populations of birds. Environmental regulations require replanting and restoration of wetlands destroyed by pipelaying barges and associated onshore pipeline installation. As these birds move to undisturbed areas of similar habitat, their presence may augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space or food. Pipeline landfalls and terminals, and other onshore OCS-related construction, can destroy coastal bird feeding or nesting habitat and can displace coastal bird populations from affected areas. Seabird nesting colonies are especially sensitive and should always be avoided by construction activities. Onshore pipelines cross a wide variety of coastal environments, including freshwater marsh and canals, and can therefore affect certain species generally not associated with marine or estuarine systems. These include certain waders, marsh birds, shorebirds, and waterfowl. For a proposed action in the WPA, 0-1 new pipeline landfalls (**Chapter 4.1.2.1.7**) and 0-1 new gas processing plants (**Chapter 4.1.2.1.4.2**) are projected.

The analysis of the potential impacts to coastal environments (**Chapter 4.2.1.1**) concludes that a proposed action in the WPA is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. Grand Isle is the only inhabited beach area on the Louisiana coast, but many unoccupied beaches occur. Initial adverse impacts and more secondary impacts of pipeline and navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands. Initial impacts are locally significant and largely limited to where OCS-related canals and channels pass through wetlands. Secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found.

Debris

Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that 80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxon (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals including lethal and chronically damaging substances (Ryan, 1990; Sileo et al., 1990a). Effects of plastic ingestion may last a lifetime and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could reduce survival rates and breeding success. Accumulation of plastic debris near foraging areas for seabird nesting colonies would be devastating to a whole cohort of fledging birds, especially industrial substances not intended to be associated with food consumption and other human activities where a health hazard would result. The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of ingested plastic found within the gut of examined birds varied greatly among species. Species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the GOM, these include the phalaropes, petrels, storm petrels, and shearwaters. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters, went into effect January 1, 1989, and is enforced by the USCG.

Structures

Every spring, migratory land birds, including neotropical passerines that cannot feed at the water surface or rest there, cross the GOM from wintering grounds in Latin America to breeding grounds north of the GOM. Some birds use offshore platforms as stopover sites for this migration that may enhance fitness.

Migrants sometimes arrive at certain platforms shortly after nightfall and proceed to circle those platforms (the phenomenon is called a nocturnal circulation event) for variable periods ranging from minutes to hours. Russell (2005) notes that "because of the anecdotal nature of our circulation observations, we are reluctant even to speculate about the average duration of participation in circulation or the typical energetic consequences of participating in these events." The number of birds participating in these circulations at one time at one platform was measured at 1,260 individuals. It is projected that 28-41 platforms are projected to be installed as a result of a proposed action in the WPA.

Summary and Conclusion

The majority of effects resulting from a proposed action in the WPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts from pipeline and navigation canals to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

4.2.1.1.8. Impacts on Fish Resources and Essential Fish Habitat

Effects on fish resources and essential fish habitat (EFH) from activities associated with a proposed action could result from coastal environmental degradation, marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from routine activities resulting from a proposed action in the WPA on fish resources and EFH are described below. Potential effects on the habitats of particular concern for GOM fish resources (the Flower Garden Banks National Marine Sanctuary, the eight newly designated topographic features, Weeks Bay National Estuarine Research Reserve, and Grand Bay) are included under the analyses for topographic features (**Chapter 4.2.1.1.4.1.1**) and wetlands (**Chapter 4.2.1.1.3.2**) respectively. Potential effects from accidental events (blowouts and spills) are described in **Chapter 4.4.10**. Potential effects on commercial fishing from a proposed action are described in **Chapter 4.1.2.1.1.9**.

Healthy fish resources and fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described in **Chapter 3.2.8**) for managed fish species in the WPA, the EFH for the GOM includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of fish species within the WPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas and Louisiana may be affected by activities resulting from a proposed action (**Chapter 4.2.1.1.3.2**). These activities include construction of new onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (**Chapter 4.2.1.1.2.1**) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species within the WPA are dependent on offshore water and a variety of specific bottom types including hard substrate, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the WPA are listed in **Table 3-3**. Planning area boundary changes have resulted in both Geyer and Elvers Banks becoming part of the CPA. They were previously in the WPA. A total of 22 named topographic features are now located within the WPA. A detailed discussion of artificial reefs appears in **Appendix A.4**. Three banks in the WPA are of particular importance; Stetson Bank and the East and West Flower Garden Banks comprise the Flower Garden Banks National Marine Sanctuary and are considered EFH Habitat Areas of Particular Concern (HAPC). Five other banks in the WPA were recently designated as HAPC in GMFMC (2005): McNeil, 29 Fathom, Rankin 1 and 2, and Bright Bank. Although the two Rankin Bank features are separated from Bright Bank by several miles and water depths of over 110 m, all three features were combined into a single HAPC in GMFMC (2005).

A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Topographic Features Stipulation (**Chapter 2.3.1.3.1**; **Figure 2-1**) would prevent most of the potential impacts from a proposed action on topographic feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills. As the result of recent GOM multibeam bathymetric surveys, it has become known that there are additional areas of sensitive biological habitat near many topographic features but outside of existing MMS-designated No Activity Zones (GMFMC, 2005). Although the Topographic Features Stipulation does not apply to these areas, the new NTL 2004-G05 includes a new category, *Potentially Sensitive Biological Features*, specifically intended to protect these kinds of habitats outside of previously identified areas.

Impact-producing factors from routine offshore activities that could result in marine water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (**Chapter 4.2.1.1.2.2**). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (**Chapter 4.3.1**). Coastal operations could indirectly affect marine water quality through the migration of contaminated coastal waters (**Chapter 4.2.1.1.2.1**).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of all production in a lease block (**Chapter 4.1.1.11**). Seventy percent of the platforms in water depths less than 200 m (656 ft) are removed by severing their pilings with explosives placed 5 m (15 ft) below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). There has been concern over a possible connection between the explosive removal of platforms and a possible impact on overall fish stocks of those species closely associated with structures, particularly red snapper. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA Fisheries and has investigated fish death associated with explosive structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the GOM. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the GOM (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but sublethal physiological irritation to fish resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question.

Drilling muds can contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m (3,281 ft), and is usually undetectable at distances greater than 3,000 m (9,842 ft) (Kennicutt, 1995) (**Chapter 4.1.1.4.1**). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. In the recent past, there has been increased media focus on mercury uptake in fish and other marine species (Raines 2001 and 2002). Information from MMS' studies was used to support the conclusion that drilling activities and platform structures were responsible for elevated levels of mercury in commercial fish. However, the MMS study referenced (Kennicutt, 1995) was misrepresented, resulting in misleading and incorrect conclusions. An MMS-funded study titled *Gulf of Mexico Offshore Operations Monitoring Experiment* (Kennicutt, 1995) analyzed sediments at three sites in the GOM. Results of this study indicated that mercury levels were slightly elevated in sediments or organisms at one platform site (High Island Block A-389). The average concentration of mercury at High Island Block A-389 was twice as high as the other two platforms. The highest average concentration (0.41 μg/g) was found within 50 m of the platform but decreased to 0.12 μg/g at 100 m (328 ft). Although these concentrations were the highest found, they were low relative to the probable effects level (0.7) believed to cause biological effects. This platform used the relatively rare practice of shunting drilling muds and cuttings to within 10 m (33 ft) of the seafloor to avoid dispersal and prevent impact to the nearby East Flower Garden Bank.

Metal concentrations were measured in tissues for 37 marine species. Fish tissue concentrations were generally low; for example, the average concentration was 0.45 μg/g for all flounder species, 0.39 μg/g all hake species, and 0.24 μg/g for all snapper species. Shrimp had statistically higher tissue concentrations (0.36 μg/g) near platforms than far (0.19 μg/g) from platforms. These values are well below the Federal guidelines set by Food and Drug Administration (FDA) to protect human health, which is 1 ppm. From the above study results, scientists concluded that platforms do not contribute to higher mercury levels in marine organisms.

A more recent synthesis report on mercury from oil and gas exploration and production by Neff (2002) concluded that the concentration of total mercury in sediments near most all of 30 platforms studied in the GOM is at or near natural background concentrations (about 0.1 ppm) and is rarely over 0.5 ppm. In addition, a key finding was that a large number of monitoring studies show that mercury concentrations in seafood from the GOM are similar to those of seafood from other parts of the world, including areas with little or no oil and gas operations. The amount of mercury entering the GOM from all offshore oil and gas facilities contributes only 0.3 percent of the mercury coming from the air and Mississippi River (Neff 2002). Additional discussion of mercury in drilling muds can be found in **Chapter 4.1.1.4.1**.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids that have a potential to adversely affect fishery resources. Some petroleum and metal contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997c). Gallaway et al. (1981) reported that the produced-water discharge impacts on platform biofouling communities were limited to a distance of 1 m vertically in the water column and 10 m (33 ft) horizontally. No significant levels of trace metals were found in tissues of any platform associated fish species including spadefish, sheepshead, blennies, and red snapper. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m (3,281 ft) and are undetectable at a distance of 3,000 m (9,842 ft) from the discharge point (Harper, 1986; Rabalais et al., 1991; CSA 1997; Kennicutt, 1995).

Proposed Action Analysis

The effects of a proposed action on coastal wetlands and coastal water quality, with the exception of accidental events, are analyzed in detail in **Chapters 4.2.1.1.3.2 and 4.2.1.1.2.1**, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation in this EIS. The effects of a proposed action on offshore live bottoms and marine water quality are analyzed in detail in **Chapters 4.2.2.1.4.1.1 and 4.2.1.1.2.2**, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation in this EIS. The direct and/or indirect effects from coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Coastal Environmental Degradation

A proposed action is projected to increase traffic in navigation channels to and from service bases in Texas and Louisiana. This may result in some erosion of wetlands along the channels, particularly in Louisiana. Additional information regarding erosion along navigation channels is provided in the wetland analysis (**Chapters 4.2.1.1.3.2**).

A total of 9-16 new pipeline landfalls are projected in support of a proposed action through 2012. Depending on the site of this projected pipeline landfall, the activities associated with the installation could result in localized impacts to the coastal environment including degradation of water quality and potential erosion and loss of wetlands habitat.

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A proposed action in the WPA is projected to contribute about 1 percent of the OCS-Program-related use of these facilities.

Maintenance dredging of waterways and channels would result in decreased water clarity and some resuspension of contaminants. This could preclude, in rare instances, uses of those waters directly affected by the dredging operations for up to several months. The periods between projected dredging operations, ranging from 1-2 years, should generally allow for the recovery of affected areas. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH. Wetlands that could be impacted for some period of time or converted to open water are discussed in the wetlands analysis (**Chapter 4.2.1.1.3.2**). Recovery of fish resources or EFH can occur from more than 99 percent, but not all, of the potential coastal environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation and most EFH can recuperate quickly, but the loss of wetlands as EFH could be permanent. At the expected level of effect, the resultant influence on fish resources or EFH from a proposed action would be negligible and indistinguishable from natural population variations.

Marine Environmental Degradation

The Topographic Features Stipulation would prevent most of the potential impacts from a proposed action on topographic-feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills resulting from a proposed action. The application of the new category of *Potentially Sensitive Biological Features* in NTL 2004-G05 will also serve to prevent impacts to hard bottom EFH habitat associated with topographic features that may lie outside previously defined No Activity Zones. For any activities associated with a proposed action, USEPA's Region 6 will regulate discharge requirements for the WPA through their NPDES permits. Contaminant levels in the WPA are generally low, reflecting the lack of pollution sources and high-energy environment of much of the region. The primary water quality impact from any increased turbidity would be decreased water clarity. Bottom disturbance from structure emplacement operations associated with a proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants.

The major sources of routine discharges to marine waters associated with a proposed action are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Both of these discharges contain various contaminants of concern (e.g., trace metals and petroleum-based organic) that may have environmental consequences on localized marine water quality and aquatic life. Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m (3,281 ft) of the discharge point. Produced-water discharges contain components and properties potentially detrimental to fish resources. Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m (3,281 ft) of the discharge point.

The projected total number of platform installations resulting from a proposed action in the WPA is 28-41 for all water depths. Almost immediately after a platform is installed, the structure would be acting as an artificial reef. After just a few years, many of the fish species present would be residents and not new transients from nearby live bottoms. Reef-building corals have been recently documented colonizing numerous platforms after approximately 10 years in areas with high year-round water quality (Sammarco et al., 2004). Black corals (antipatharians) have also been reported on some structures (Boland and Sammarco, 2005). Structure emplacements can act as FAD's and can result in aggregation of highly migratory fish species. A number of commercially important highly migratory species, such as tunas and marlins, are known to congregate and be caught around FAD's. Attraction of pelagic, highly migratory species to offshore structures will likely occur to some degree. Some positive impacts to commercial fishing resulting from fish aggregating around deepwater structures may be possible.

All structures associated with a proposed action are expected to be decommissioned by 2046. It is expected that the number of structures converted to artificial reefs after decommissioning (rigs to reefs) will increase over time. Since the inception of the program, a total of approximately 250 platforms have been converted to artificial reefs. Structure removal results in artificial habitat loss and causes fish kills when explosives are used. Most multi-leg platforms in water depths less than 156 m are removed by severing their pilings with explosives placed 5 m (15 ft) below the seafloor. It is projected that 11-17 structures in water depths <200 m (656 ft) in the WPA will be removed using explosives as a result of a proposed action. It is expected that structure removals would have a negligible effect on fish resources because these activities kill only those fish proximate to the removal site.

The projected length of pipeline installations for a proposed action is 130-760 km (81-472 mi). Trenching for pipeline burial has the potential to adversely affect fish resources. It is assumed that 5.02 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 60-420 km (37-261 mi) of pipelines in water depths less than 200 ft (61 m). Where pipeline burial is necessary, a jetting sled is generally used. Water jets are directed downward to dig a trench and the apparatus can lay pipe at an average of 1.6 km/day (1.0 mi/day) (see **Chapters 4.1.1.3.8.1 and 4.1.2.1.7** for additional discussion of pipelaying activities). Sandy sediments would be quickly redeposited within 400 m (1,312 ft) of the trench or blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters (yards) over a period of 30 days or longer. Any affected population is expected to recover to predisturbance condition in one generation. At the expected level of impact, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations.

It is expected that marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations. Recovery of fish resources or EFH can occur from 100 percent of the potential marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation. Offshore live bottoms including "pinnacles" and topographic features are not expected to be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by USEPA NPDES permits. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

Summary and Conclusion

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will experience little or no impact. Live bottoms within No Activity Zones will be completely avoided by all impacting activities. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

Additional hard substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase fish populations. Removal of these structures will eliminate that habitat except when decommissioning results in platforms being used as artificial reef material. This practice is expected to increase over time.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

4.2.1.1.9. Impacts on Commercial Fishing

Effects on commercial fishing from activities associated with a proposed action could result from installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, subsurface blowouts, pipeline trenching, and petroleum spills. Potential effects from routine activities resulting from a proposed action in the WPA on fish resources and EFH are described in **Chapter 4.2.1.1.8**. Potential effects from accidental events (spills and blowouts) are described in **Chapter 4.4.10**. Potential effects on commercial fishing from routine activities resulting from a proposed action are described below.

Since the majority of the commercial species harvested within the WPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality.

Wetlands and estuaries within Texas and Louisiana may be affected by activities resulting from a proposed action (**Chapters 4.2.1.1.3.2 and 4.4.3.2**). These activities include construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (**Chapters 4.2.1.1.2.1 and 4.4.2.1**) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species harvested within the WPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH in the WPA does not include named Pinnacle Trend blocks but does include natural (topographic features) and artificial reefs. Natural banks within the WPA are listed in **Table 3-3**. A detailed discussion of artificial reefs appears in **Appendix A.4**. A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Topographic Features Stipulation (**Chapter 2.3.1.3.1**) would prevent most of the potential impacts from a proposed action on live-bottom communities/EFH from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills. The NTL 2004-G05 includes an additional category of protected features, *Potentially Sensitive Biological Features*, which will serve to protect unnamed or yet-to-be discovered habitat areas outside named topographic feature No Activity Zones or the Pinnacle Trend blocks of the WPA.

Impact-producing factors from routine offshore activities that could result in degradation of marine water quality include platform and pipeline installation, platform removal, and the discharge of operational wastes (**Chapter 4.2.1.1.2.2**). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter marine water quality (**Chapter 4.3.1**). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (**Chapter 4.4.2.1**).

The area occupied by structures, anchor cables, and safety zones associated with a proposed action would be unavailable to commercial fishermen and could cause space-use conflicts (CSA, 2002) (**Chapter 4.1.1.3.3.2**). Exploratory drilling rigs would spend approximately 30-150 days onsite and would cause short-lived interference to commercial fishing. A bottom-founded, major production platform in shallow water, with a surrounding 100-m (328-ft) navigational safety zone, requires approximately 3 ha (7 ac) of space. A major production facility in deep water (>1,000 ft or 305 m) could obtain special USCG safety zone designation with a 500-m (1,640-ft) radius exclusion zone for vessels larger than 100 ft (30.5 m) in length requiring 78 ha (193 ac) of space. The use of FPSO's is not projected for a proposed action in water depth <800 m (2,625 ft). In depths over 800 m (2,625 ft), 0-3 FPSO's are projected as the result of a proposed action in the WPA or CPA. The USCG has not yet determined what size of a navigational safety zone would be required for an FPSO during normal or offloading operations. Any designated safety zone would restrict commercial fishing activities.

Underwater OCS obstructions, such as pipelines, can cause loss of trawls and catch, business downtime, and vessel damage. Pipelines in water depths <200 ft (61 m) are required to be buried, and their locations made public knowledge. Although Gulf fishermen are experiencing some economic loss from gear losses, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear losses are covered by the Fishermen's Contingency Fund (FCF) (**Chapter 1.3**).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of all production in a lease block (**Chapter 4.1.1.11**). Seventy percent of the platforms in water depths less than 200 m (656 ft) are removed by severing their pilings with explosives placed 5 m (15 ft) below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). There has been concern over a possible connection between the explosive removal of platforms and a possible impact on overall fish stocks of those species closely associated with structures, particularly red snapper. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA and its Fisheries Service and has investigated fish death associated with explosive structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the GOM. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the GOM (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small, and would not alter current determinations of stock status or current management recovery strategies.

Chronic, low-level pollution is a persistent condition, resulting in frequent but sublethal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected. The geographic range of the effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource.

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m (3,281 ft), and is usually undetectable at distances greater than 3,000 m (9,842 ft) (Kennicutt, 1995) (**Chapter 4.1.1.4.1**). A recent synthesis report on mercury from oil and gas exploration and production by Neff (2002) concluded that the concentration of total mercury in sediments near most all of 30 platforms studied in the GOM is at or near natural background concentrations (about 0.1 ppm) and is rarely over 0.5 ppm. Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. From the above study results, scientists concluded that platforms do not contribute to higher mercury levels in marine organisms.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m (3,281 ft) and are undetectable at a distance of 3,000 m (9,842 ft) from the discharge point (Harper, 1986; Rabalais et al., 1991; CSA 1997; Kennicutt, 1995).

Proposed Action Analysis

Installation of offshore structures may cause space-use conflicts with commercial fishing activities. The total projected number of production structure installation for a proposed action ranges from 28 to 41. Using the 500-m (1,640-ft) navigational safety zone figure (although to date very few operators have elected to apply to the USCG for a safety zone around production platforms), the possible area excluded from commercial trawl fishing or longlining would be approximately 78 ha (193 ac). A navigational safety zone does not necessarily exclude all commercial fishing if vessels are less than 100 ft in length. The excluded area represents only a very small fraction of the total area of the WPA. All structures associated with a proposed action are projected to be removed by the year 2046.

In water depths less than 200 m (656 ft), the area of concentrated bottom trawl fishing, 21-31 platforms would be installed under a proposed action, eliminating 126-186 ha (311-460 ac) from the area available for commercial fishing. There is no use of FPSO's projected for a proposed action in less than 800 m (2,625 ft). The effect of space loss to trawl fishing resulting from the construction of platforms in support of a proposed action in the WPA would be negligible; the maximum extent of the area lost to commercial trawling would be less than 0.01 percent of the available trawl fishing area in water depths less than 200 m (656 ft).

Both of the two large areas in the DeSoto Canyon Area closed to longline fishing by NOAA Fisheries Service are in the CPA and EPA (**Chapter 3.2.8.1**). The closed areas cover nearly 845,000 km^2 (326,256 mi^2) and will displace commercial longlining, which may increase activity in the remaining parts of the CPA and possibly the WPA.

Underwater OCS obstructions such as pipelines may cause fishing gear loss and additional user conflicts. The area of concentrated bottom trawl fishing is in water depths less than 200 m (656 ft). For a proposed action, it is projected that 60-420 km (37-261 mi) of pipeline will be installed in water depths less than 60 m (197 ft); no projection of the length of installed pipelines has been made for water depths of 60-200 m (197-656 ft). Gear loss and user conflicts are mitigated by the FCF. Direct payments for claims in FY 2003 totaled $107,989 and total payments for FY 2004 were $187,429. The amount available for FCF claims in FY 2005 is $1,141,938, but final settlement data has not been posted at this writing. The majority of claims are resolved within six months of filing. The economic loss from gear loss and user conflicts has historically been less than 0.1 percent of the same year's value of Gulf commercial fisheries landings. It is assumed that installed pipelines will seldom conflict with bottom trawl or other fishing activities, and they are expected to have a negligible effect on commercial fishing.

Structure removals result in loss of artificial-reef habitat and cause fish kills when explosives are used. It is projected that 10-16 structure removals using explosives will occur in water depths of <200 m (656 ft) as a result of each proposed sale action. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys will occur in both shallow and deepwater areas of the WPA. Usually, fishermen are precluded from a very small area for several days. The common fishing practices in the GOM include bottom trawling, purse netting, bottom longlining, and surface longlining. These fishing practices are the most vulnerable to conflicts because they not very mobile and use gear types that require considerable time to deploy and retrieve. It is now well documented that intense sounds such as those produced by seismic airguns affect the spatial distribution of fishes during and following exposure, thus affecting the commercial catch by trawl or hook-and-line within the exposure area and for a certain period post-exposure. Løkkeberg (1991) and Engås et al. (1993) reported that the cod catch (by trawl) was reduced (80% to 50% reduction) during and following seismic shooting in the North Sea off the coast of Norway. The calculated sound pressure levels received by the fish were 191 and 160 dB, respectively. In the Pacific, off the coast of California, Skalski et al. (1992) found that calculated received levels of 161 dB caused rockfish (*Sebastes* sp.) to change behavior and to show alarm reactions at 180 dB and startle reactions at 200-205 dB. Reduced catch by hook-and-line could be caused by fish moving away or changing feeding behaviors. In any case, there are sufficient observations in the literature to conclude that airgun shooting may cause a temporary reduction in the commercial fish catch within at least several kilometers of the ensonified area. The claims that seismic survey sounds will damage fish ears in the wild are a different question.

There has been some concern about the impact of seismic sounds affecting the ears of fish. The single paper referred to most frequently (McCauley et al., 2003) used conditions and exposures very different from what would be experienced in natural environments. In McCauley et al. (2003) pink snapper (*Pagrus auratus*) were held in cages as small as 1 m^3 in a bay with an average depth of only 9 m (30 ft). The captive fish were approached by the seismic airgun source as close as 5 m (16 ft) a total of seven times with a peak pressure every pass of over 180 dB. These conditions would likely never be experienced by fish in the wild. As acknowledged in the paper, it would be likely that fish would swim away from the airgun source as it approached if possible as demonstrated in other research (Engås et al., 1993). Although the fish ear epithelia showed damage apparently related to the sound impacts (a mean of 2.7% missing ear hair cells compared to total number), there was no indication what level was required to produce the damage observed or if recovery would have occurred after sacrificing all the test animals after 58 days.

To state it simply, there is virtually no chance that any fish species will follow or somehow be restricted to within a few meters of seismic airgun sources for multiple exposures of over 180 dB of pressure waves. Temporary presence of seismic surveys should not impact the annual landings or value of landings for commercial fisheries in the Gulf. The GOM species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Loss of fishing gear because of seismic surveys is also mitigated (see above) by the FCF. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners*, a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

Summary and Conclusion

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Seismic surveys are not expected to cause long-term or permanent displacement of any listed species from critical habitat/preferred habitat or to result in destruction or adverse modification of critical habitat or essential fish habitat. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

4.2.1.1.10. Impacts on Recreational Fishing

This section discusses the possible effects of a proposed action on recreational fishing. Impact-producing factors associated with a proposed lease sale that could directly impact recreational fishing in the offshore environment include the presence of offshore structures, pipeline installation activities, and spills. Potential effects from accidental events including oil spills on recreational fishing are described in **Chapter 4.4.11.** This section discusses potential direct effects from the presence of offshore structures and pipeline installation activities, and includes a consideration of damage to recreational fishing after the 2005 hurricane season.

Recreational fishing could be indirectly impacted by adverse effects of a proposed action on fish stocks or EFH. The discussions of impacts of the proposed action on fish resources and EFH (**Chapter 4.2.1.1.8**) and of impacts of a proposed action on commercial fisheries (**Chapter 4.2.1.1.9**) also apply to recreational fishing. The analysis of fish populations is particularly relevant to recreational fishing impacts.

A significant proportion of the U.S. fishing industry is located in the GOM. Thirty percent (approximately 26 million trips in 2004) of all saltwater recreational fishing trips occur in this region (USDOC, NMFS, 2004). In 2001, 2.9 million anglers spent approximately 30 million days saltwater fishing. They generated $3 billion in retail sales annually, that in turn, produced $5.7 billion in economic output and supported 57,535 jobs (Roussel, 2005). Hurricanes Katrina and Rita impacted recreational fishing from the Florida panhandle through Texas. It is estimated that over $1.2 billion was lost due to the hurricanes' impact on recreational fisheries (Roussel, 2005). It is estimated that Texas lost approximately 1,056 recreational fishing trips and $1,227,530 in associated gross revenues following the Hurricane Rita and that 958 charter/headboats were damaged due to the storm (USDOC, NMFS MRFSS, 2005). Before Hurricane Rita, there were approximately 1.1 million sportfishing trips in Texas, 155,021 of which were charter trips. The 2004 annual economic impact of recreational fishing in the GOM off the coast of Texas was approximately $273 million (Texas Department of Fish and Game 2004).

Despite the damage to recreational fishing after the 2005 hurricane season, assessments indicate that many of the most valuable fish stocks in the region remain at or above the previous year's levels. Seafood samples indicate that toxic substances are well below the FDA's guidelines. The lack of infrastructure is one of the largest obstacles to recovery of the recreational fishing industry although this is even a greater problem for commercial harvesters that rely on the supporting infrastructure to operate (e.g., seafood dealers, processors, and suppliers). Other forms of support infrastructure are more closely tied to recreational anglers (e.g., bait shops, marinas, etc.) (Lautenbacher, 2006).

Proposed Action Analysis

The most significant impact of routine operations on recreational fisheries is likely to result from space use conflicts. Placement of MODU's disturbs the seafloor, causes turbidity, and may temporarily drive fishes away from the general area. These activities would primarily affect soft bottom species such as red drum, sand sea trout, and spotted sea trout sought by anglers in private or charter/party vessels. Fishes would, however, eventually return to the disturbed area.

The introduction of high-profile structures, specifically drilling rigs and platforms, into a lease sale area frequented by offshore fishermen is the development activity most likely to affect fish and recreational fishing. About 58.5 percent of all recreational fishing trips made in the eastern and central Gulf (Florida, Alabama, Mississippi, and Louisiana) during 1998 were from private and charter/party vessels (USDOI, MMS, 2001d). About 63 percent of these trips were made in inland waters, with the remainder (37%) of the trips made in inshore or offshore waters of the GOM. The presence of structures would have a FAD effect on pelagic (e.g., king mackerels, tunas, cobia) and reef-associated species (e.g., red snapper, gray triggerfish, amberjack) which would also make them attractive to most recreational fishers. Rigs and platforms function as very large *de facto* artificial reefs. They attract and concentrate sport fish and stimulate the growth of marine life, which, in turn, attract fishermen and divers (Bull et al., 1997). Many studies (Ditton and Auyong, 1984; Roberts and Thompson, 1983; Ditton and Graefe, 1978; Dugas et al., 1979) have demonstrated that, when GOM petroleum structures are accessible to marine recreational fishermen and scuba divers, the structures are a major attraction throughout their entire lifetime for marine recreational fishing and are a positive influence on tourism and coastal economics.

Almost all offshore recreational fishing is currently confined within 100 mi (161 km) of shore. Very few fishing trips go beyond the 200-m (656-ft) contour line. The introduction of 23-33 production facilities in 0-200 m (656 ft) as a result of a proposed action could attract recreational fishermen to pursue game fish attracted to these structures. Even if production facilities applied for and established 500-m (1,640-ft) safety zones, this would not exclude any recreational fishing vessel less than 100 ft in length. Fishing prospects are likely to improve by those choosing to fish in the immediate vicinity of rigs and platforms.

Oil and gas development and production resulting from this proposal would require the installation of pipelines to gather and transport petroleum products to onshore processing and refining facilities. Short-term, space-use conflict could occur during the time that any pipeline is being installed.

Summary and Conclusion

The development of oil and gas in the proposed lease sale area could attract additional recreational fishing activity to structures installed on productive leases. Each structure placed in the GOM to produce oil or gas would function as a *de facto* artificial reef, attract sport fish, and improve fishing prospects in the immediate vicinity of platforms. This impact would last for the life of the structure, until the structures are removed from the location and the marine environment. A proposed action would have a beneficial effect on offshore and deep-sea recreational fishing within developed leases accessible to fishermen. These effects would last until the production structures are removed from the marine environment. Short-term space-use conflict could occur during the time that any pipeline is being installed.

4.2.1.1.11. Impacts on Recreational Resources

This section discusses the possible effects of a proposed action in the WPA on recreational beaches. Millions of annual visitors attracted to these resources are responsible for thousands of local jobs and billions of dollars in regional economic activity. Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the GOM and that support a multiplicity of recreational activities, most of which are focused at the land and water interface. Included are Gulf Islands National Seashore, State parks and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas. The general locations of these beaches are indicated on MMS Visual 2—Multiple Use (USDOI, MMS, 2001c).

The primary impact-producing factors to the enjoyment and use of recreational beaches are trash and debris, and oil spills. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation, and noise from OCS-related aircraft can adversely affect a beach-related recreation experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The potential impacts from oil spills and other accidental events are discussed in **Chapter 4.4.12**.

The value of recreation and tourism in the GOM coastal zone from Texas through Florida has been estimated in the tens of billions of dollars annually (USDOI, MMS, 2001a; pages III-101 and III-102). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. Over one million people visit the mainland unit and barrier island beaches of the Gulf Island National Seashore in Mississippi and Florida annually, demonstrating the popularity of destination beach parks throughout the Gulf Coast region east of the Mississippi River. Trash and debris from OCS operations can wash ashore on GOM recreational beaches. Recreational beaches west of the Mississippi River are the most likely to be impacted by waterborne trash from OCS activities. Litter on recreational beaches from OCS operations could adversely affect the ambience of the beach environment, detract from the enjoyment of beach activities, and increase administrative costs on maintained beaches. Some trash items, such as glass, pieces of steel, and drums with chemical residues, can also be a health threat to users of recreational beaches. Current industry waste management practices; training and awareness programs focused on the beach litter problem; and the OCS industry's continuing efforts to minimize, track, and control offshore wastes are expected to minimize potential for accidental loss of solid wastes from OCS oil and gas operations.

The physical presence of platforms and drilling rigs visible from shore, and noise associated with vessels and aircraft traveling between coastal shore bases and offshore operation sites can adversely affect the natural ambience of primitive coastal beaches. Drilling rigs and platforms placed 3-10 mi from shore are within sight range of shoreline recreational beaches. Federal and State oil and gas operations are already occurring on nearshore tracts off Louisiana, Mississippi, and Alabama.

Although these factors may affect the quality of recreational experiences, they are unlikely to reduce the number of recreational visits to coastal beaches in the Western Gulf.

Proposed Action Analysis

A proposed action in the WPA is projected to result in the drilling of 87-125 exploration and production wells and the installation of 21-31 platforms in water depths <60 m (197 ft). In water depths of 60-200 m (656 ft), a proposed action is projected to result in 18-22 wells and 2 platforms. The WPA is 10 mi (17 km) from Texas; therefore, no structures installed as a result of a WPA proposed action would be visible from shore. Marine debris will be lost from time to time from OCS operations associated with drilling activities and production facilities projected to result from a proposed action in the WPA. Waste management practices and training programs are expected to minimize the level of accidental loss of solid wastes from activities resulting from a proposed action. Recreational beaches in Louisiana and Texas are most likely to be impacted by any waterborne trash. Beached litter and debris from a proposed action is unlikely to be perceptible to beach users or administrators because a proposed action would constitute only a small percentage of the total OCS Program activity in the WPA.

A proposed action is expected to result in 94,000-155,000 service-vessel trips over the life of the leases or about 2,350-3,875 operations (take-off and landing) annually. A proposed action is also expected to result in 400,000-900,000 helicopter operations, which is about 10,000-22,500 operations annually. Service vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at least 90 percent of the time. This additional helicopter and vessel traffic will add very little noise pollution likely to affect beach users.

Summary and Conclusion

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

4.2.1.1.12. Impacts on Archaeological Resources

Blocks with a high potential for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the Western Gulf. Blocks with a high potential for prehistoric archaeological resources are found landward of the 12,000 B.P. paleo-shoreline position, which is roughly approximated by the 45-m bathymetric contour. Because of inherent uncertainties in both the depth of historic sea level stands and the entry date of prehistoric man into North America, MMS has adopted the 60-m (197-ft) water depth as the seaward extent of the area considered to have potential for prehistoric archaeological resources.

The areas of the northern GOM that are considered to have high potential for historic period shipwrecks were redefined as a result of an MMS-funded study (Pearson et al., 2003; NTL 2006-G07). The 2003 study refined the shipwreck database in the GOM, initially developed by a previous MMS-funded study (Garrison et al., 1989), and identified new areas along the approach to the Mississippi River that have a high potential for containing historic shipwrecks. The Garrison et al. (1989) study used statistical analysis of shipwreck location data to identify two specific types of high-potential areas—the first within 10-km (6-mi) of the shoreline and the second proximal to historic ports, barrier islands, and other loss traps. High-potential search polygons associated with individual shipwrecks were also created to afford protection to wrecks located outside the two aforementioned high-potential areas. The Pearson et al. study incorporated this model into their recommendations, and the historic archaeological high-potential areas are under MMS review at the time of this writing. The MMS requires a 50-m remote-sensing survey linespacing for historic shipwreck surveys in water depths of 200-m (656-ft) or less. The current NTL—NTL 2005-G07, effective July 01, 2005—supersedes all other archaeological NTL's and LTL's, and updates requirements to reflect current technology. The list of lease blocks requiring an archaeological survey and assessment are identified in NTL 2006-G07.

An Archaeological Resources Stipulation was included in all GOM lease sales from 1973 through 1994. The stipulation has been incorporated into operational regulations, which can be found at 30 CFR 250.194. All protective measures offered in the Stipulation have been adopted in this regulation.

Additional supportive material for the archaeological resources analysis is provided in **Chapter 3.3.2** (Description of the Affected Environment) and **Chapters 4.2.1.12, 4.2.2.1.14, 4.4.15, and 4.5.14** (Environmental Consequences).

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity or anchors having an impact on an historic shipwreck. Direct physical contact with a wreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the period from which the ship dates.

The placement of drilling rigs and production systems has the potential to cause physical impact to prehistoric and/or historic archaeological resources. The area of seafloor disturbance from each of these structures is defined in **Chapter 4.1.1.3.2.1**. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric and/or historic archaeological resources. Pipelines placed in water depths of less than 61 m must be buried. Burial depths of 1 m are required with the exception of shipping fairways and anchorage areas, where the requirements are 3.0 m and 4.6 m, respectively.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to historic shipwrecks (Espey, Huston, & Associates, 1990a). There are many navigation channels that provide OCS access to onshore facilities; most are located in the Central Gulf.

Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipelaying barge.

Activities resulting from a proposed action will generate ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

4.2.1.1.12.1. Historic

Proposed Action Analysis

The likely locations of archaeological sites cannot be delineated without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS regulations that require OCS lessees and operators and applicants for pipeline rights-of-way to conduct an archaeological survey prior to proposed activities within areas determined to have a high potential for historic and/or prehistoric archaeological resources are described in **Chapter 1.5**. Generally, in the western part of the WPA, where unconsolidated sediments are thick, it is likely that sidescan sonar will not detect shipwrecks buried beneath the mud. In this area, the effectiveness of the survey for detecting historic shipwrecks of composite and wooden construction would depend on the capability of a magnetometer to detect ferromagnetic masses of the size characteristically associated with shipwrecks. It is assumed that the required 50-m line spacing (as specified in NTL 2005-G07) is a highly effective survey methodology, allowing detection and avoidance of historic shipwrecks within the survey area. The survey would therefore minimize the potential impacts to historic shipwrecks.

According to estimates presented in **Table 4-2**, 197-287 exploration, delineation, and development wells will be drilled and 28-41 production platforms will be installed in support of a proposed action. Of these, 104-147 exploration, delineation, and development wells will be drilled, and 23-33 platforms will be installed in water depths of 200 m (656 ft) or less, where the majority of blocks having a high potential for historic period shipwrecks are located. The location of any proposed activity within a lease that has a high potential for historic shipwrecks requires archaeological clearance prior to operations. Considering that the expanded MMS shipwreck database contains 494 reported shipwrecks in the entire Western Gulf OCS (**Table 3-33**), the potential of an OCS activity contacting and damaging a shipwreck is very low. If an oil and gas structure contacted a historic resource, however, there could be a loss of significant or unique archaeological information.

Because there is only a thin Holocene sediment veneer overlying an indurated Pleistocene surface in the eastern part of the WPA, shipwrecks are more likely to be detected by side-scan sonar; therefore, the 50-m survey linespacing is expected to be even more effective (95%) for reducing the potential for a direct physical contact between an impact-producing factor and a shipwreck in the eastern WPA. There is a very small possibility that a historic shipwreck could be impacted by OCS activities. Should such an impact occur, however, significant or unique archaeological information could be lost.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. Historic sites that have yet to be identified may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development could result in the direct physical contact between the construction of new onshore facilities or pipeline canals and previously unidentified historic sites. This direct physical contact with a historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. It is assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. **Table 4-9** shows the projected coastal infrastructure related to OCS Program activities. Facilities that are projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or communities. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites in the WPA from onshore development.

Maintenance dredging in support of activities resulting from a proposed action has the potential to impact a historic shipwreck. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to impact the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. The MMS assessment indicates that, under a proposed action, less than 1 percent of the ship traffic through the Port Mansfield Cut is related to OCS use. Therefore, the impact to the *Santa Maria de Yciar* and *SS Mary* directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. While the specific example falls within EIA TX-1, an area unlikely to be affected by activities resulting from a proposed action in the WPA, it serves to illustrate that the potential exists for historic shipwrecks to be impacted by dredging. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. Proposed action activities represent <1 percent of the usage of the major navigation channels for the Western Gulf.

The loss of ferromagnetic debris during exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. Under a proposed action, it is expected that hundreds of tons of ferromagnetic debris will be lost overboard. It is expected that most ferromagnetic debris associated with OCS structures will be removed from the seafloor during site-clearance activities. Site clearance, however, takes place after the useful life of the structure is complete. It has been noted that such debris has the potential to be moved from the area of initial deposition as a result of trawling activities (Garrison et al., 1989). Also, no site-clearance activities are required for pipeline emplacement operations. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and gas activities.

Since all platform locations within the high-potential areas for the occurrence of offshore historic and prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the WPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Pearson et al., 2003) resulted in refinement of the areas assessed as having high potential for historic period shipwrecks. An MMS review of the historic high-potential areas is occurring at the time of this writing. The NTL for archaeological resource surveys in the GOM Region, NTL 2005-G07, mandates a 50-m linespacing for remote-sensing surveys of leases within areas having high potential for historic shipwrecks in water depths 200 m (656 ft) or less, and 300-m linespacing in water depths greater than 200 m (656 ft). NTL 2006-G07 identifies those lease blocks that have been designated as having a high potential for containing historic shipwrecks.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the WPA are not expected to impact historic archaeological resources. It is conservatively assumed that about 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action (**Table 4-9**). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the WPA are not expected to affect historic archaeological resources.

4.2.1.1.12.2. Prehistoric

Offshore development as a result of a proposed action could result in an interaction between a drilling rig, a platform, a pipeline, dredging, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenance and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Proposed Action Analysis

According to projections presented in **Table 4-2**, under a proposed action, 197-287 exploration, delineation, and development wells will be drilled, and 28-41 production platforms will be installed as a result of a proposed action in the WPA. Relative-sea-level data for the GOM indicates that there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m (197 ft). If only the area likely to contain prehistoric sites (shallower than 60 m (197 ft)) is considered, 87-125 exploration, delineation, and development wells and 21-31 production platforms are projected to be installed (**Table 4-2**). The limited amount of impact to the seafloor throughout the WPA, the required archaeological survey, and archaeological clearance are sufficient to assume a low potential for impacting a prehistoric archaeological site. Should such an impact occur, damage to or loss of significant or unique prehistoric archaeological information could occur.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. At present, unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of a proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. It is assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. **Table 4-9** shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There should, therefore, be no impact to onshore WPA prehistoric sites from onshore development related to a proposed action.

Each platform location within the high-potential areas for the occurrence of historic and prehistoric archaeological resources requires archaeological clearance prior to setting the structure; therefore, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structural Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

Several impact-producing factors may threaten the prehistoric archaeological resources of the Western Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant and/or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the WPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

4.2.1.1.13. Impacts on Human Resources and Land Use

This proposed action analysis considers the effects of OCS-related, impact producing activities from a proposed WPA lease sale in relation to the continuing baseline of non-OCS-related factors. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity from State waters, offshore LNG activity, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but cannot be predicted are not considered in this analysis.

4.2.1.1.13.1. Land Use and Coastal Infrastructure

Chapters 3.3.5.1.2 and 3.3.5.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. Except for the projected 0-1 new gas processing plants, the proposed action will require no new oil and gas coastal infrastructure. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle development. There is also sufficient land to construct the projected new gas processing plant in the analysis area.

The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed WPA lease sale would not alter the current land use of the area.

4.2.1.1.13.2. Demographics

In this section, MMS projects how and where future demographic changes will occur and whether they correlate with a proposed WPA lease sale. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions and land use.

Proposed Action Analysis

Population

Population projections related to activities resulting from a proposed action are expressed as total population numbers and as a percentage of the population levels that would be expected if the proposed lease sale were not held (**Tables 4-20 and 4-21**). **Chapter 3.3.5.4.1** discusses baseline population projections for the analysis area through 2030. Because the baseline projections assume the continuation of existing social, economic, and technological trends at the time of the forecast, they also include population changes associated with the continuation of current patterns in OCS Program activities. Population impacts from a proposed action in the WPA mirror the assumptions for employment impacts described in **Chapter 4.2.1.13.3** below. Projected population changes reflect the number of people dependent on income from OCS-related employment for their livelihood (e.g., family members of oil and gas workers), which is based on the ratio of population to employment in the analysis area over the life of a proposed lease sale. The population projections due to a proposed WPA lease sale are calculated by multiplying the employment projections (**Chapter 4.2.1.1.13.3,** Economic Factors, and **Tables 4-22 and 4-23**) by a ratio of the baseline population (**Table 3-35**) to the baseline employment (**Table 3-41**). Note that EIA's LA-1, LA-2, LA-3, LA-4, MA-1, and AL-1 correspond to the offshore CPA; TX-1, TX-2, and TX-3 correspond to the WPA; and FL-1, FL-2, FL-3 and FL-4 correspond to the EPA.

Population associated with a proposed WPA lease sale is estimated at about 8,186-10,294 persons during the peak year of impact (year 3) for the low- and high-case scenarios, respectively. While population associated with a typical WPA lease sale as proposed is projected to peak in year 3, years 5, 7, and 8 also display close to peak levels of population. During the years of peak or near-peak population, a substantial amount of platform and pipeline installations are projected in association with a proposed WPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, therefore, leading to employment and population impacts.

Population impacts from a proposed action in the WPA are expected to be minimal, i.e., less than 1 percent of total population for any EIA. The mix of males to females is expected to remain unchanged. The increase in employment is expected to be met primarily with the existing population and available labor force with the exception of some in-migration.

Age

If a proposed WPA lease sale is held, the age distribution of the analysis area is expected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed in **Chapter 3.3.5.4.2** is expected to continue through the year 2046. Activities relating to a proposed action in the WPA are not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged if a proposed WPA lease sale is held. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in **Chapter 3.3.5.4.3** is expected to continue through the year 2046. (See **Chapters 3.3.5.4.1 and 3.3.5.4.3** for a discussion of race and ethnic composition changes as a result of Hurricanes Katrina and Rita.)

Summary and Conclusion

Activities relating to a proposed WPA lease sale are expected to affect minimally the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one EIA. Baseline patterns and distributions of these factors, as described in C**hapter 3.3.5.4**, are expected to approximately maintain the same level. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

4.2.1.1.13.3. Economic Factors

The oil and gas industry is significant to the coastal communities of the GOM, particularly in south Louisiana and eastern Texas. The economic analysis for a proposed lease sale in the WPA focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the analysis region defined in **Chapter 3.3.5.1**. To improve regional economic impact assessments and to make them more consistent across planning areas, MMS developed a new model called MMS Alaska-GOM Model Using IMPLAN (MAG-PLAN) for estimating changes to employment and other economic factors (Saha et al., 2005). The MAG-PLAN retains the two-stage process of the older MMS models. The first-stage estimates the expenditures required to support the activity levels in a specific exploration and development scenario, and allocates these expenditures to the various industrial sectors in the onshore geographic units of interest. The activities are meant to be comprehensive, including exploration drilling, platform fabrication and installation, pipeline construction and installation, and various other construction and maintenance functions required to support the phases of development. The proposed action scenario (**Tables 4-1 and 4-2**) is an estimate of the oil-and-gas-related activities that could plausibly take place as the result of a proposed action. High- and low-range estimates of activity drawn from this scenario form the basis for a range of estimates of employment and personal income effects.

The second step in the process estimates how the initial dollars spent in a geographic area reverberate through the economy. Stage II of MAG-PLAN uses multipliers taken from the widely used IMPLAN model to estimate the employment, income, and other economic effects. For each of these economic effects, the model estimates direct, indirect, induced, and total effects. In standard usage, the direct effects would refer to the spending of the oil and gas industry as a result of the projects being analyzed, as well as the employment, income, and other such effects caused by that spending. Indirect effects are those that arise from subsequent rounds of spending by contractors, vendors, and other businesses. Induced effects arise from the spending of worker households. However, while total effects remain the same, most "direct" MAG-PLAN estimates include the first round of indirect and induced effects. The MAG-PLAN direct effects can be thought of as the effects of local payroll and non-payroll expenditures of oil and gas companies, as well as of their immediate suppliers.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably by the phase of OCS activity and by the water depth of the OCS activities. For example, an exploratory well in 0-60 m (0-197 ft) of water is expected to cost significantly less than a similar well in 800 m (2,625 ft) or greater water depth to complete. In addition, spending on materials such as steel will be much higher for platform fabrication and installation than for operations and maintenance once production begins. Therefore, the model estimates and allocates expenditures for the scenario activities in seven water-depth categories: 0-60 m (0-197 ft), 61-200 m (197-656 ft), 201-400 m (659-1,312 ft), 401-800 m (1,316-2,625 ft), 801-1,600 m (2,628-5,249 ft), 1,601-2,400 m (5,253-7,874 ft), and over 2,400 m (7,874 ft). In addition, the model estimates and allocates expenditures for both drilling scenario activities (exploratory, production, and nonproduction wells drilled) and workovers by three well-depth categories for each of the seven water-depth categories. Because local economies vary, a separate set of IMPLAN multipliers is used for each EIA to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in the number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

The projections in this section are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Energy projections are subject to much uncertainty. Many of the events that shape energy markets cannot be anticipated, such as severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Given this, MMS has endeavored to make these projections as objective, reliable, and useful as possible.

Proposed Action Analysis

Total employment projections for activities resulting from a proposed action are expressed as absolute numbers and as a percentage of the baseline employment projections described in **Chapter 3.3.5.5 and** presented in **Tables 4-22, 4-23, and 4-24**. Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Population impacts, described in **Chapter 4.2.1.13.2** (**Tables 4-20 and 4-21**, mirror those assumptions associated with employment. Based on model results, direct employment associated with a proposed WPA lease sale is estimated at about 2,550-3,250 jobs during the peak impact year for the low- and high-case scenarios, respectively. Indirect employment is projected at about 900-1,100 jobs, while induced employment is calculated to be about 1,200-1,500 jobs for the low- and high-case scenarios, respectively. Therefore, total employment resulting from a proposed WPA lease sale is not expected to exceed 4,650-5,850 jobs in any given year over a proposed action's 40-year lifetime. However, a portion of these employment estimates do not represent "new" jobs. Many of these jobs would represent new contracts or orders at existing firms. These contracts would essentially keep the firm operating at its existing level as earlier contracts and orders are completed or filled. In other words, a portion of these 4,650-5,850 jobs would be staffed with existing company labor force and would simply maintain the status quo. Thus, these employment estimates should be considered to overestimate the actual magnitude of new employment effects from the proposed action.

Most of the employment related to a proposed WPA action is expected to occur in Texas (EIA TX-3) and Louisiana (EIA's LA-2 and LA-3). Considering Florida's current opposition to oil and gas development in offshore waters and the scarcity, if not absence, of onshore supporting service bases, MMS anticipates that very few OCS-related activities will be staged from Florida. Current model results seem to project more employment in the early years than anticipated based on previous experience. In addition, model results for direct, and hence total, employment in Florida may be too high because of the existing methodology used to allocate expenditures onshore for the state. The MMS will reexamine these results in the Final EIS. Although most of the employment related to a proposed WPA action is expected to occur in EIA TX-3, employment is not expected to exceed 1 percent of the total employment in any given EIA of Texas, Louisiana, Mississippi, Alabama, or Florida (**Table 4-24)**. On a percentage basis, EIA LA-2 is projected to have the greatest employment impact at 0.3 percent; EIA LA-3 is projected to have the next greatest employment impacts at 0.2 percent; and EIA's LA-4 and TX-3 are projected to have employment impacts at 0.1 percent each.

Summary and Conclusion

Should a proposed WPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, Alabama, and Florida EIA's. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force for reasons discussed above.

4.2.1.1.13.4. Environmental Justice

The analysis of environmental justice concerns is divided into those related to routine operations (below) and those related to oil spills (**Chapter 4.4.14.4**). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). **Chapter 3.3.5** describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities. The MMS estimates that production from a proposed action in the WPA will be 0.242-0.423 BBO and 1.644-2.647 tcf of gas.

Proposed Action Analysis

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. A proposed action in the WPA is expected to increase slightly employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. **Figures 3-21 through 3-26** display the geographic distribution of low income and minority residents across GOM counties and parishes. As stated in **Chapter 3.3.5.10** and displayed in **Figures 3-21 through 3-26**, there are communities that could exhibit disproportionate effects on low income or minority groups in the region. Ten counties (or parishes in Louisiana) are considered to have a high concentration of oil-related infrastructure (**Table 3-40**). Of these 10 counties, 5 have higher minority percentages than their respective State average. These counties are Mobile, Alabama; St. Mary, Louisiana; and Galveston, Harris, and Jefferson, Texas. Only 2 of the 10 high infrastructure concentration counties also have higher poverty rates than their respective State poverty rate. Both St. Mary Parish, Louisiana, and Jefferson County, Texas, have higher poverty rates than the mean poverty rates in their states. Many of these low income and minority populations are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of industry activity, effects of a proposed action are not expected to be disproportionate.

The widespread economic effects of a proposed action on minority and low-income populations are expected to be mostly positive. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector; therefore, it affected white male employment more than that of women or minorities (Singelmann, personal communication, 2006). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an OCS-related plant in one rural town were much higher than reemployment rates related to similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While a proposed action will provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice concerns often arise from the possible siting of infrastructure in places that will have disproportionate and negative effects on minority and low-income populations. Since a proposed action will help to maintain ongoing levels of activity rather than expand them, no one proposed lease sale will generate new infrastructure demand sufficient to raise siting issues. For this reason, this EIS considers infrastructure projections only for the cumulative analysis (**Chapter 4.5.15.4**). The cumulative analysis concludes that, as with the analysis of employment effects of a proposed action, infrastructure effects are expected to be widely and thinly distributed. Since the siting of new infrastructure will reflect the distribution of the petroleum industry and not that of minority and low-income populations, the OCS activity resulting from a proposed action in the WPA is not expected to disproportionately affect these populations. Again, Lafourche Parish is identified as a location of more concentrated effects. Each OCS-related facility constructed onshore must first receive approval by the relevant Federal, State, county or parish, and community involved, and MMS assumes that new construction will be approved only if consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Summary and Conclusion

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a proposed action in the WPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on these populations.

Future changes in activity levels will most likely be caused by fluctuations in oil prices and imports, and not by activities related to a proposed action. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.2.1.2. Alternative B – The Proposed Actions Excluding the Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (proposed action) by not offering blocks of that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.3.1.3.1**). All of the assumptions (including the six other potential mitigating measures) and estimates are the same as for a proposed action (Alternative A). A description of Alternative A is presented in **Chapter 2.3.1.1**.

The Federal offshore area is divided into subareas based on water depths in m (W0-60, W60-200, W200-400, W400-800, W800-1600, W1600-2400, and W>2400), and the adjacent coastal region is divided into three EIA's (TX-1, TX-2, and TX-3). These subareas and EIA's are delineated on **Figures 4-2 and 3-12**, respectively.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the WPA (Alternative A). The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. These are estimates only and not predictions of what will happen as a result of holding a proposed sale. A detailed discussion of the scenario and related impact-producing factors is presented in **Chapter 4.1**.

The analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts under Alternative B are expected to be the same as those under a typical proposed action in the WPA (**Chapter 4.2.1**) for the following resources:

–Air Quality
–Water Quality
–Sensitive Coastal Environments
–Live Bottoms (Pinnacle Trend)
–Continental Slope and Deepwater Benthic Communities
–Marine Mammals
–Sea Turtles
–Coastal and Marine Birds
–Fish Resources and Essential Fish Habitat
–Commercial Fishing
–Recreational Fishing
–Recreational Resources
–Archaeological Resources
–Human Resources and Land Use

The impacts to some GOM resources under Alternative B would be different from the impacts expected under a proposed action. These impacts are described below.

Impacts on Sensitive Offshore Resources

Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for a proposed action. The potential impact-producing factors to the topographic features of the Western Gulf are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors is presented in **Chapter 4.2.1.1.4.1.1**.

All 21 topographic features of the WPA are located within water depths less than 200 m (656 ft). These features occupy a very small portion of the entire area. Of the potential impact-producing factors that may affect the topographic features, anchoring, structure emplacement, and structure removal will be eliminated by the adoption of this alternative. Effluent discharge and blowouts will not be a threat to the topographic features because blocks near enough to the banks for these events to have an impact on the biota of the banks will have been excluded from leasing under this alternative. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill. The potential impacts from oil spills are summarized below and are discussed further in **Chapter 4.4.4.1.2**.

A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. There is a 24-32 percent chance that one pipeline spill ≥1,000 bbl would occur and a 4-9 percent chance that a second pipeline spill ≥1,000 bbl would occur as a result of a WPA proposed action. The chance of a substantial amount of oil being release during a loss of well control (LOWC) is 3 percent. There is one LOWC estimated to occur in less than 200 m (656 ft) as a result of a WPA proposed action. A subsurface spill is expected to rise to the surface, and any oil remaining at depth will be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Deepwater subsurface spills may travel along the sea bottom or in the water column for some distance before rising to the surface. The fact that the topographic features are widely dispersed in the Western Gulf, combined with the random nature of spill events, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. **Chapter 4.3.1.8** discussed the risk of spills interacting with topographic features, especially the Flower Garden Banks, in more detail. The currents that move around the banks will likely steer any spilled oil around the banks rather than directly upon them, lessening impact severity. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary) (CSA, 1992b and 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill contacted a coral-covered area (in the case of the Flower Garden Banks), the areal extent of coral mortality would be limited, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature, diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Conclusion

Alternative B is expected to cause little or no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill contacts the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Some lethal effects would probably occur upon oil contact to coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary); recovery from such an event is anticipated to occur within a period of 2 years.

4.2.1.3. Alternative C — Use of a Nomination and Tract Selection Leasing System

Description of the Alternative

This alternative would offer for lease for each proposed action a maximum of 300 industry-nominated blocks and would offer all blocks that become available for leasing after the industry nomination deadline and before the FNOS is published for that proposed action. The same exclusions described under the proposed action(s) would apply. The number of tracts offered would be about 25 percent of the tracts estimated to be offered under an areawide leasing system (Alternative A), and it is estimated this alternative would result in a 25 percent reduction in the number of tracts leased per proposed action.

Effects of the Alternative

The analyses of impacts described in detail in **Chapter 4.2.1** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapters 4.1.1 and 4.1.2**.

Based on recent leasing patterns, it is assumed the offered tracts would be evenly distributed throughout the 28.6-million-ac WPA sale area. Under nomination and tract selection leasing, it is assumed the best tracts would be made available and leased; therefore, the success rate of the leased tracts would be higher than the success rate under areawide leasing. Although the number of resulting leases would be reduced, the estimated amount of resources under Alternative C would still fall within the range projected to be developed as a result of any one proposed CPA lease sale (0.242-0.423 BBO and 1.644-2.647 Tcf of gas) under Alternative A (**Chapter 4.1**). Therefore, the impacts to environmental and socioeconomic resources under Alternative C are expected to be the same as those estimated under a typical proposed action in the WPA (**Chapter 4.2.1**) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
–Live Bottoms (Pinnacle Trend and Topographic Features)
–Deepwater Benthic Communities
–Air Quality
–Marine Mammals
–Sea Turtles
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Commercial Fisheries
–Socioeconomic Conditions

Summary and Conclusion

The assumption that the levels and location of activity for Alternative C are essentially the same as those projected for the proposed actions for Alternative A leads to the conclusion that the impacts expected to result from Alternative C would be very similar to those described under the proposed actions (**Chapters 4.2.1 and 4.4**). Therefore, the regional impact levels for all resources would be similar to those described under the proposed actions.

4.2.1.4. Alternative D — No Action

Description of the Alternative

Alternative D is equivalent to cancellation of a lease sale scheduled for a specific period in the *Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012.* By canceling a proposed lease sale, the opportunity is postponed or foregone for development of the estimated 0.242-0.423 BBO and 1.644-2.647 Tcf of gas. Any potential environmental and socioeconomic impacts resulting from a proposed sale (**Chapter 4.2.1**, Alternative A — The Proposed Actions) would be postponed or not occur.

Effects of the Alternative

Under Alternative D, the USDOI cancels a planned WPA lease sale. Therefore, the discovery and development of oil and gas expected from a lease sale would be delayed or would not occur. The environmental and socioeconomic effects of Alternative A (proposed action) also would be delayed or not occur. Other sources of energy may substitute for the delayed or lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have their own significant negative environmental and socioeconomic impacts.

This section briefly discusses the most likely alternative energy sources, the quantities expected to be needed, and the environmental and socioeconomic impacts associated with these alternative energy sources. The discussion is based on material from the following MMS publications: *Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (USDOI, MMS, 2006l); *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012, Draft Environmental Impact Statement* (USDOI, MMS, 2006m); and *Energy Alternatives and the Environment* (USDOI, MMS, 2001e). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost Through No Lease Sale

Energy Alternatives and the Environment (USDOI, MMS, 2001e) discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from the lease sale would come from four sources:

- additional imports;
- conservation;
- additional domestic production; and
- fuel switching.

Additional domestic production and imports would augment supply, while conservation and switching to alternative fuels shift demand downward. The table below shows the percentage and range of quantities expected to be needed to substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	Percent of Lost Oil Production	Range of Oil Quantity (MMbbl)	Percent of Lost Gas Production	Range of Gas Quantity (Bcf)
Imports	86-88%	208-372	16%	263-424
Conservation	6-7%	15-30	16-17%	263-450
Additional Domestic Production	3%	7-13	26-28%	427-741
Fuel Switching	4-5%	10-21	40-42%	658-1,112
Total Production Lost through No Sale	100%	242-423	100%	1,644-2,647

Notes: Bcf = billion cubic feet.
MMbbl = million barrels.

Environmental and Socioeconomic Impacts from the Most Likely Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);
- degradation of water quality from oil spills related to accidental discharges or tanker casualties;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas; and
- increasing public concern about tanker spills.

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources—Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation); and
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter).

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology would tend to result in positive net gains to the environment. The amount of gain would depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation.

Fuel Switching: The most likely substitutes for natural gas are oil, which would further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own negative environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* (USDOI, MMS, 2001e) discusses many of the alternatives at a level of detail impossible here.

Summary and Conclusion

Canceling a lease sale would eliminate the effects described for Alternative A (**Chapter 4.2.1**). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant negative environmental impacts of their own.

4.2.2. Alternatives for Proposed Central Gulf Sales 205, 206, 208, 213, 216, and 222

4.2.2.1. Alternative A – The Proposed Actions

4.2.2.1.1. Impacts on Air Quality

The following activities would potentially affect air quality: platform construction and emplacement; platform operations; drilling activities; flaring; seismic-survey and support-vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in **Chapters 3.1.1** (description of the coastal air quality status of the Gulf coastal area), **4.1.1.6** (air emissions), and **4.1.19** (hydrogen sulfide), and **Appendix A.3** (description of the meteorology of the northern GOM). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and the mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and nitrogen dioxide constitute nitrogen oxide (NO_x) emissions. Nitrogen oxide, a by-product of all combustion processes, is emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation (i.e., acid rain).

Carbon monoxide (CO) is a by-product of incomplete combustion, primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood, reducing the transfer of oxygen within the body. CO particularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide (SO_2) may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide reacts in the atmosphere, principally with water vapor and oxygen, producing sulfuric acid, which along with nitric acid are the major constituents of acid rain. Acid rain can be harmful to animals, vegetation, and materials. The flaring of natural gas containing hydrogen sulfide (H_2S) and the burning of liquid hydrocarbons containing sulfur (**Chapter 4.1.1.9**) result in the formation of SO_2. The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. Natural gas from the Norphlet Formation in the northeastern portion of the CPA, just south of Alabama and Mississippi, tends to range between 40 and 140 ppm on the OCS. Nevertheless, two wells are known to have H_2S concentrations of 1.8 and 2.5 percent (18,000 ppm and 25,000 ppm, respectively) in the OCS. Higher concentrations do occur within the Norphlet Formation farther north under State territorial waters and below land.

Additionally, the area around the Mississippi River Delta is a known sulfur-producing area. The natural gas in deepwater reservoirs has been mainly sweet (i.e., low in sulfur content), but the oil averages between 1 and 4 percent sulfur content by weight. By far, most of the documented production of sour gas (i.e., high sulfur content) lies within 150 km (93 mi) of the Breton National Wilderness Area.

Flaring of sour gas is of concern because it could significantly impact onshore areas, particularly when considering the short-duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid hydrocarbon fuel is the primary source of sulfur oxides (SO_x), when considering the annual averaging period; however, impacts from high-rate well cleanup operations can generate significant SO_2 emissions. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hr and 24-hr averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the postlease process.

Volatile organic compounds (VOC's) are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's is the vents on glycol dehydrator stills.

Particulate matter, also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. The size of particles is directly linked to their potential for causing health problems. The USEPA is concerned about particles that are 10 mm in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. The USEPA groups particle pollution into two categories:

- "Coarse particles," such as those found near roadways and dusty industries, range in size from 2.5 to 10 mm in diameter.
- "Fine particles," such as those found in smoke and haze, have diameters smaller than 2.5 mm. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries, and automobiles react in the air.

The PM_{10} can also affect visibility, primarily because of the scattering of light by the particles and, to a lesser extent, light absorption by the particles. This analysis considers mainly total suspended particulate (PM_{10}) matter.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the troposphere (i.e., lower level of the atmosphere) from complex chemical reactions involving VOC's and NO_x in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who work or exercise strenuously outdoors are particularly sensitive to elevated ozone concentrations.

Emissions of air pollutants would occur during exploration, development, and production activities. The profile of typical emissions for exploratory and development drilling activities (**Chapter 4.1.1.6**) shows that emissions of NO_x are the most prevalent pollutant of concern. These emission estimates are based on a drilling scenario of a 3,674-m (12,055-ft) hole during exploration activities and a 3,050-m (10,000-ft) hole during development activities. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole.

Platform emission rates for the GOM region (**Chapter 4.1.1.6**) are provided from the 2000 emission inventory of OCS sources compiled by MMS (Wilson et al., 2004). This compilation was based on information from a survey of 3,154 platforms from 93 companies, which represented an 85 percent response rate. Since these responses included all the major oil and gas production facilities, they were deemed representative of the type of emissions to be associated with a platform. The NO_x and VOC's are the primary pollutants of concern, since both are considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were taken from the OCS emission inventory (Wilson et al., 2004).

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the wellbore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions table and in the modeling analysis (since platform emissions included flaring along with all other sources).

Accidents, such as oil spills, blowouts and pipeline ruptures, are another source of emissions related to OCS operations. The potential impacts from these accidental events are discussed in **Chapter 4.4.1**.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing net wind circulation. During summer, the wind regime in the CPA is predominantly onshore at mean speeds of 3-5 m/sec (6.7-11.2 mph). Average winter winds are predominantly offshore at speeds of 4-8 m/sec (8.9-17.9 mph).

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the CPA (Florida A&M University, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions; these stagnant conditions generally result in the worst periods of air quality. Although mixing height information throughout the GOM is scarce, measurements near Panama City (Hsu, 1979) show that the mixing height can vary between 400 and 1,300 m, with a mean of 900 m (2,953 ft). The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Proposed Action Analysis

The OCS emissions in tons per year for the criteria pollutants for the proposed action are indicated in **Table 4-25**. The major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. The drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 40-day drilling period. Support activities for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and the offshore facilities; a smaller percentage of the emissions occur during idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

The total pollutant emissions per year are not uniform. At the beginning of the proposed activities, emissions would be the largest. Emissions peak early on, as development and production start relatively quickly, leading to increased production. After reaching a maximum, emissions would decrease as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

The MMS regulations (30 CFR 250.303) establish 1-hr and 8-hr significance levels for CO. A comparison of the projected emission rate to the MMS exemption level would be used to assess CO impacts. The formula to compute the emission rate in tons/yr for CO is $3,400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the GOM Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas including the Houston/Galveston, Port Arthur/ Lake Charles, and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under a proposed action would not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.303(f)(2) requires that if a facility would significantly impact (defined as exceeding the MMS significance levels) an onshore nonattainment area, then it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well. The new 8-hour ozone standard (0.085 ppm) has been fully implemented as of August 2005. It is more stringent than the previous 1-hour standard, but did not result in more areas being classified as nonattainment for ozone. In response to the new ozone standard, updated ozone modeling was performed using a preliminary Gulfwide emissions inventory for the year 2000 to examine the O_3 impacts with respect to the new 8-hour ozone standard. Two modeling studies were conducted, one modeling study focused on the coastal areas of Louisiana extending eastward to Florida (Haney et al., 2004). This study showed that the impacts of OCS emissions on onshore O_3 levels were very small, with the maximum contribution of 1 ppb or less at locations where the standard was exceeded. The other modeling effort dealt with O_3 levels in Southeast Texas (Yarwood et al., 2004). The results of this study indicated a maximum contribution of 0.2 ppb or less to areas exceeding the standard.

Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible. It is estimated that over 99 percent of the gas and oil would be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer would be small, as would the associated exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Louisiana (Marine Vapor Recovery Act, 1996: LAC: 33:III.2108).

The MMS studied the impacts of offshore emissions using the Offshore and Coastal Dispersion (OCD) Model. Three large areas in the CPA were modeled. The limiting factor on the size of each area was the run time needed to process the number of sources. The areas modeled were a 150-km (93-mi) circle centered over Breton Island, a 100-km (62-mi) circle centered over the Grand Isle area, and a 150-mi (241 mi) circle over the Vermilion area. Receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The Breton area was chosen to capture the Class I area. The other two areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. Emissions for a proposed action were projected and compared to the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. Only the onshore maximum concentrations reported for all of the runs are discussed. The results of the runs are reported in the **Tables 4-26 and 4-27**. The results are also compared with the federally allowable increases in ambient concentrations as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Tables 4-26 and 4-27 list the highest predicted contributions to onshore pollutant concentrations from OCS activities, as well as the maximum allowable increases over a baseline concentration established under the air quality regulations. While the tables show that a proposed lease sale alone would result in concentration increases that are well within the maximum allowable limits for Class I and Class II areas, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The PM_{10} are emitted at a substantially smaller rate than NO_2 and SO_2; hence, impacts from PM_{10} would be expected to be small. As a proposed action in the CPA would represent approximately 4-5 percent of OCS activities in the CPA, emissions from activities resulting from a proposed action would be substantially below the maximum allowable limits for a Class II area.

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter (diameter of a sphere) that would have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 μm and a third peak with diameters larger than 2 μm. Particles with diameters of 2 μm or larger settle very close to the source (residence time of approximately ½ day, Lyons and Scott, 1990). For particles smaller than 2 μm, which do not settle fast, wind transport determines their impacts. Projected PM_{10} concentrations are expected to have a low impact on the visibility of PSD Class I areas.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with the size in the range of 1 to 2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute tot he visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area. Since future air emission from all sources in the area are expected to be about the same level or less, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

The Breton National Wilderness Area is a Class I air quality area administered by FWS. Under the Clean Air Act, MMS would notify the FWS and National Park Service if emissions from proposed projects may impact the Breton Class I area. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km (62 mi) of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed action activities are expected to be well within the NAAQS. A proposed action would have only a small effect on ozone levels in ozone nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas.

4.2.2.1.2. Impacts on Water Quality

The routine activities that would impact water quality include the following:

- discharges during drilling of exploration and development wells;
- workover of a well;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- workovers of wells
- service vessel discharges; and
- nonpoint-source runoff.

4.2.2.1.2.1. Coastal Waters

Proposed Action Analysis

In coastal waters, the water quality would be impacted by the discharges from the service vessels in port. The types of discharges and regulations were discussed in **Chapters 4.1.1.4.8** and **4.1.2.2.2.** Most discharges are treated or otherwise managed prior to release. In coastal waters, bilge and ballast water may be discharged with an oil content of 15 ppm or less. The discharges would affect the water quality locally. The USCG Ballast Water Management Program may apply to some vessels and is designed to prevent the introduction on non-indigenous (invasive) species. Estimates of the volume of bilge and ballast water that may be discharged are not available.

Supporting onshore facilities discharge into local wastewater treatment plants and waterways during routine operations. The types of onshore facilities were discussed in **Chapter 4.1.2.2.1.** All point-source discharges are regulated by the USEPA the agency responsible for coastal water quality or the USEPA-authorized State agency. The USEPA NPDES storm water effluent limitation guidelines control storm water discharges from support facilities. Nonpoint-source runoff, such as rainfall, which has drained from infrastructure such as a public road, may contribute hydrocarbon and trace-metal pollutants. Data are not available to make estimates of the impact from this type of discharge.

Summary and Conclusion

The primary impacting sources to water quality in coastal waters are point-source and storm water discharges from support facilities, vessel discharges, and nonpoint-source runoff. The impacts to coastal water quality from a proposed action should be minimal as long as all existing regulatory requirements are met.

4.2.2.1.2.2. Marine Waters

Proposed Action Analysis

Drilling Muds and Cuttings

The drilling of exploratory and development wells results in the discharges of drilling fluids, called "muds," and cuttings. Although muds and cuttings have different characteristics, their impacts are discussed together since they are simultaneously discharged when WBF is used. Only cuttings wetted with SBF are permitted for discharge when SBF is used. The majority of the CPA falls within the jurisdiction of USEPA Region 6 and NPDES permit GMG29000. The eastern portion of the CPA falls within the jurisdiction of USEPA Region 4 and NPDES permit GMG460000. The USEPA Region 6 permits restrict the type and amount of mud and cuttings that can be discharged. The USEPA Region 4 similarly regulates muds and cuttings discharges in the portion of the MMS CPA that falls under its jurisdiction.

The MMS estimates that a proposed action would result in 65-96 exploratory and delineation wells and 330-468 development wells being drilled over the life of a proposed action. It is assumed that 80 percent of wells will be drilled with SBF and 20 percent with WBF.

Most studies of cuttings volumes generated when drilling with WBF have determined a cuttings volume in the range of 1,500-2,500 bbl cuttings per well (USEPA, 1993; Avanti Corporation, 1997). The volume of WBF used and assumed discharged per well is about 7,000-9,700 bbl (USEPA, 1993). The following cuttings volumes were determined in studies prior to the permitting of SBF use: 565 bbl for a shallow development well; 855 bbl for a deep development well; 1,184 bbl for a shallow exploratory well; and 1,901 bbl cuttings for a deep exploratory well (USEPA, 2000). Drilling as a result of the proposed action with WBF would create 158,000-338,000 bbl of cuttings and 549,000-1,090,000 bbl of WBF waste. Drilling as a result of the proposed action with SBF would create 211,000-466,000 bbl of cuttings. Although the discharge of SBF fluid is not permitted, the discharge of cuttings containing a small percentage of adhered SBF is permitted.

The fate and effects of WBF and cuttings have been extensively studied throughout the world (Engelhardt et al., 1989). The primary environmental concerns associated with WBF are the increased turbidity in the water column, alteration of sediment characteristics because of the addition of coarse material in cuttings, and trace metals. Occasionally, formation fluids may be discharged with the cuttings, adding hydrocarbon contamination, which may require treatment before discharge. The WBF are rapidly dispersed in the water column immediately after discharge, and the solids descend to the seafloor (Neff, 1987). The greatest effects to the benthos are within 100-200 m (328-656 ft), primarily due to the increased coarsening of the sediment by cuttings. Most of the components of the WBF have low toxicity with the exception of some trace metals. Barium is the major element in the mud because of the required large amounts of barite used, but trace amounts of chromium, copper, cadmium, mercury, lead, and zinc are also present. The trace mercury concentrations in barite are bound in sulfur compounds and not available for biological methylation or subsequent bioconcentration (Trefrey et al., 2002). Significant elevations of all these metals except chromium were observed within 500 m (1,640 ft) of six GOM drilling sites on the continental shelf (Boothe and Presley, 1989). The USEPA guidelines limit the levels of cadmium and mercury in stock barite to 3.0 mg per kilogram (kg) and 1.0 mg/kg (dry weight), respectively. A study of chronic impacts from oil and gas activities (Kennicutt, 1995) determined that metals from discharges, including mercury and cadmium, were localized to within 150 m (492 ft) of the structure. Highest levels of metal contaminants were attributed to a platform where discharges are shunted to within 10 m (33 ft) of the bottom.

Cuttings wetted with SBF do not disperse readily in the water column and therefore are not expected to adversely affect water quality. The greater the percentage of SBF removed from the cuttings prior to discharge, the more the discharge disperses similarly to WBF and WBF cuttings. Since the SBF settle very close to the discharge point, the local sediments are affected. The primary affects are alteration of sediment grain size, and addition of organic matter, which can result in localized anoxia while the SBF degrade. In a study of shelf and slope locations where cuttings wetted with SBF had been discharged, the cuttings were deposited within a 100 - to 250-m distance from the discharge point (CSA, 2004). The cuttings were identifiable in the impacted sediment because they were a different size and composition from the naturally occurring sediment. Elevated barium concentrations because of barite were also present. The SBF are synthesized hydrocarbons rather than a petroleum product and initially the area is organically enriched. Over time, bacteria and fungi decompose the SBF. During biodegradation, oxygen is depleted and anaerobic processes take over. In comparison to background sediments, the SBF-enriched, surficial sediments become anoxic and indicators of anaerobic respiration such as sulfide and ammonia increase in concentration. As SBF concentrations decrease, the impacted sediments begin to recover. Bioaccumulation tests also indicate that SBF and their degradation products should not significantly bioaccumulate. It is expected that discharged cuttings should degrade within 2-3 years after cessation of discharge (Neff et al., 2000; CSA, 2004).

The MMS recently completed a field study of four drilling sites located on the slope in water depths of 1,033-1,125 m (3,389-3,691 ft) (CSA, 2006). Sample collection before and after exploration or development drilling documented the drilling-related changes to sediment at near-field and far-field locations. Sediment barium concentrations were typically enriched by greater than 10 fold at near-field versus far-field samples as a result of drilling. The average Viosca Knoll Block 916 pre-drilling sediment barium concentration was 0.09-0.1 percent barium and increased by 30-fold following drilling. Concentrations of other metals—Hg, Zn, As, and Pb—were elevated in 6-15 percent of near-field samples relative to far-field samples. An increase in sediment SBF due to the discharge of SBF-wetted cuttings was noted, although discharges had ceased 5 months to 2 years prior to sample collection. Elevated TOC and anoxic conditions corresponded with the presence of SBF. Concentrations of TOC were typically about one-third greater in near-field sediments relative to far-field sediments. Sediment profile photography showed microbial mats at more near-field sites corresponding to organic enrichment from drilling discharges.

Produced Water

Produced water is the largest waste stream generated in oil and gas production. Produced water would impact water quality by adding hydrocarbons, trace metals, and biochemical oxygen demand to the environment. As discussed in **Chapter 4.1.1.4.2**, the volume of produced water discharged from a facility ranges from 2 to 150,000 bbl/day. The MMS scenario predicts that 87 percent of development wells will actually produce. Therefore, of the 330-468 development wells drilled, an estimated 287-407 wells will produce. From 2001 to 2005, the reported volume has averaged at 0.084 MMbbl produced water per well. Consequently, the proposed action is projected to introduce 24-34 MMbbl of produced water per year. The amount of oil and grease resulting from a proposed action can be estimated from the projected annual produced water volume. Assuming the produced water consistently contains a monthly oil and grease average of 29 milligrams/liter (the NPDES permit limit for oil and grease), the volume of added hydrocarbons would be 0.25-0.35 million pounds of oil and grease per year as the result of a proposed action.

The MMS estimates that 28-39 production structures would be installed as the result of a proposed action (**Table 4-3**). Each structure may have the capacity to receive and treat greater volumes of produced water from multiple wells than structures in shallower waters. Discharges from workovers and other activities are generally mixed with the produced water and therefore must meet the same criteria.

Several studies have been conducted to evaluate the effects of produced-water discharges from platforms on the surrounding water column, sediments, and biota (e.g., Rabalais et al., 1991; Kennicutt, 1995; CSA, 1997b). The GOOMEX study (Kennicutt, 1995) examined the effects of discharges at three natural gas platforms. Effects, including increased hydrocarbons, trace metals, and coarser grain size sediments, were observed within 150 m (492 ft) of the platforms. Localized hypoxia was observed during the summer months and attributed to stratification of the water column and increased organic material near the platform. The distribution of contaminants was patchy and there were several variables that could contribute to the observations, specifically sand from cuttings, hydrocarbons, and trace metals in the porewater. It was not possible to make a definitive judgment as to the precise source of observed toxic effects in the benthic community.

A bioaccumulation study (CSA, 1997c) examined trace metals and hydrocarbons in several fish and invertebrate species near platforms on the continental shelf. The produced-water discharge and ambient seawater were also analyzed for the same compounds. Of the 60 target chemicals, two (arsenic and cadmium) were measured in the edible tissues of mollusks at levels above the USEPA risk-based concentrations. The target organic compounds were not present in most tissue samples above the target level. However, radium isotopes were measured in 55 percent of the samples, but at low concentrations.

Measurements of radium in formation water range from 40 to 1,000 pCi/l. These values are greater than marine waters, but when formation waters are discharged offshore, the radium is rapidly diluted to ambient concentrations (Reid, 1980).

The amount of oxygen demanding pollutants in produced water was determined for produced water discharged into the hypoxic zone (Veil et al., 2005) as a requirement for the reissued NPDES general permit. The mean biochemical oxygen demand (BOD) was 957 mg/l, total organic carbon (TOC) was 564 mg/l, and total Kjeldahl nitrogen (TKN) was 83 mg/l in produced waters from the platforms located within the hypoxic zone. These loadings were less than 0.5 percent of the Mississippi and Atchafalaya River nutrient loading, so, although more research is in progress, produced water is not anticipated to contribute to the annual GOM summer hypoxic zone formation. Future activities in the shelf area where the hypoxic zone occurs are expected to focus on deep gas production. Gas completions generate less produced water than oil completions.

Platform Installation and Removal

The MMS estimates that 14-16 platforms would be removed using explosives as a result of the proposed action (**Table 4-3**). As with platform removal would also result in localized sediment disturbance and an increase in turbidity within the water column. During explosive removal, gaseous by-products would be released, including carbon dioxide, nitrogen, and carbon monoxide. The increase of gaseous byproducts from explosives in the water would cause very short-term, minor alterations to the dissolved gas concentrations in the water in the immediate area of the explosion.

The MMS estimates that 10-19 platforms would be removed by methods other than explosives as a result of the proposed action. Abrasive cutting removal uses seawater and an abrasive, either copper slag or industrial garnet. These abrasives are inert solids that would be deposited on the seafloor along with metal cuttings. The presence of abrasive grit from platform removal would cause very short-term, minor increases in turbidity in the area of activity.

Other Impacting Activities

The installation of pipelines can increase the local total suspended solids in the water. These activities result in only a temporary adverse effect on water quality.

Supply-vessel traffic affects water quality through discharges of bilge water, ballast water, and domestic and sanitary wastes. Bilge water and sanitary wastes are treated before discharge. Ballast water is uncontaminated water but may come from a source with properties, such as lower or higher salinity, different from those of the receiving waters. Estimates of the volumes of these discharges are not available.

Summary and Conclusion

During exploratory activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. During installation activities, the primary impacting sources to water quality are sediment disturbance and turbidity. Impacting discharges during production activities are produced water and supply-vessel discharges. Regulations are in place to limit the levels of contaminants in these discharges. During platform removal, sediment disturbance, gaseous by-products from explosives, or abrasive grit from cutting are the impacting discharges. Impacts to marine waters from a proposed action should be minimal as long as regulatory requirements are followed.

4.2.2.1.3. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by activities resulting from a proposed action in the CPA are considered in **Chapters 4.2.2.1.3.1, 4.2.2.1.3.2, and 4.2.2.1.3.3**. Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The major, nonaccidental, impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, and construction and expansions of navigational canals, port facilities, processing facilities, pipelines, and pipeline-support facilities. The MMS has no direct regulatory authority over potential impact-producing factors or mitigation activities that may occur or be needed in the States' coastal zones.

4.2.2.1.3.1. Coastal Barrier Beaches and Associated Dunes

This section considers impacts from a proposed action in the CPA to the physical shape and structure of barrier beaches and associated dunes. The primary impact-producing activities associated with a proposed action that could affect barrier beaches and dunes include pipeline emplacements, navigation channel use (vessel traffic) and dredging, and use and construction of support infrastructure in these coastal areas. The following sections describe the sources and types of these potential impacts.

Pipeline Emplacements

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Many OCS pipelines make landfall on Louisiana's barrier island and wetland shorelines. Pipeline landfall sites on barrier islands could cause accelerated beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from modern techniques used to bring pipelines to shore, such as directional boring (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988).

Since 2002, only one new pipeline has come to shore in Louisiana from OCS-related activities. In 2003, the 30-in Endymion Oil Pipeline, which delivers crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field, was installed. Based on a review of the data in the COE permit application (No. 20-020-1632), the emplacement of the pipeline caused zero (0) impacts to marshes (emergent wetlands) and beaches because the operator used horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the pipeline route maximized an open-water route to the extent possible (a comprehensive description of current mitigative measures is discussed in **Chapter 4.5.1.3.1**). A comparison of aerial photos taken before and after Hurricanes Katrina and Rita reveal no observable landloss or impacts associated with the Endymion Oil Pipeline.

Vessel Traffic and Dredging

Vessel traffic that may support a proposed action is discussed in **Chapter 4.1.1.8.4**. Navigation channels projected to be used in support of a CPA proposed action are discussed in **Chapter 4.1.2.1.9**. Navigation channels that support the OCS Program are listed in **Table 3-36**. Current navigation channels will not change as a result of a proposed action in the CPA. In addition, no new navigation channels will be required by a proposed action in the CPA.

Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion processes. Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Louisiana coast. According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr (8.46 ft/yr), compared with 0.95 m/yr (3.12 ft/yr) for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr (4.9 ft/yr), or 300 ha (741 ac) of landloss per year for the 2,000 km (1,243 mi) of OCS-related navigation channels in the CPA. Navigation channels through the sandbars at the mouths of flowing channels generally capture and remove sediments from the longshore sediment drift if the cross-sectional area of the channel is too large for natural tidal and storm exchanges to keep swept clear. Periodic maintenance dredging is expected in existing OCS-related navigation channels through barrier passes and associated bars. Jetties designed to reduce channel shoaling and maintenance dredging of bar channels affect the stability of barrier landforms if those jetties or the bar channel serve as sediment sinks that intercept sediment in longshore drift. Dredging removes sediment from the littoral sediment drift or routes it around the beach immediately downdrift of the involved channel. Materials from maintenance dredging of bar and pass channels are either discharged to nearby ocean dump sites in the Gulf or are increasingly exploited for beneficial uses such as wetlands or beach renourishment projects (**Chapter 4.1.3.2.1**).

Continued Use of Support Infrastructure

In the past, OCS-related facilities were built in the vicinity of barrier shorelines of the CPA. The use of some existing facilities in support of a proposed action and subsequent lease sales in the CPA may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. They may also cause the accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In deltaic Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts will last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified.

Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat.

Abandoned facility sites must be cleared in accordance with Federal, State, and local government and landowner requirements. Materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

Zero to one pipeline landfalls are projected as a result of a proposed action in the CPA resulting in up to 2 km (1.2 mi) of onshore pipeline. Should one be constructed, it will most likely be in Louisiana, where the large majority of the infrastructure exists for receiving oil and gas from the CPA. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, regulatory programs and permitting processes (COE and Louisiana DNR) are sequenced to ensure wetlands are protected first through avoidance, then minimization of impacts, and finally compensation for unavoidable impacts. The use of modern technologies, such as directional boring, greatly reduces and perhaps eliminates impacts to coastal barrier islands and beaches. Therefore, effects on barrier beaches and dunes from pipeline laying activities associated with a proposed action in the CPA are expected to be minor or nonexistent. These impacts are considered to be negligible.

The average contribution of a proposed action in the CPA to OCS-related vessel traffic in navigation canals is expected to be small (2-3%). Turner and Cahoon (1988) found that OCS traffic in general comprises a relatively small percentage (~12%) of the total commercial traffic using navigation channels. Thus, the allocation of navigation channel impacts to OCS activities is small and the contribution from a proposed action is even smaller. Erosion of coastal barrier beaches and associated dunes from vessel traffic associated with a proposed action in the CPA are expected to be negligible.

Adverse impacts due to maintenance dredging of navigation channels can be mitigated by discharging dredged materials onto barrier beaches or strategically into longshore sediment currents downdrift of maintained channels or by using the dredged material to create wetlands. Adverse impacts of sediment sinks created by jetties can be further mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment. Sediment traps that are created by unnecessarily large bar channels may also be mitigated by reassessing the navigational needs of the port and by appropriately reducing the depth of the channel. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies. Effects on coastal barrier beaches and associated dunes associated with dredging from a proposed action in the CPA are expected to be restricted to minor and very localized areas downdrift of the channel.

There are 0-1 gas processing plants projected to be constructed as a result of a proposed action in the CPA. Should one be constructed, it will most likely be in Louisiana, where the large majority of the infrastructure exists for receiving oil and gas from the CPA. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, regulatory programs and permitting processes (COE and Louisiana DNR) are sequenced to ensure wetlands are protected first through avoidance, then minimization of impacts, and finally compensation for unavoidable impacts. Effects on coastal barrier beaches and associated dunes associated with construction of a gas processing plant from a proposed action in the CPA are expected to be restricted to minor and very localized areas downdrift of the channel.

Summary and Conclusion

In summary, effects to coastal barrier beaches and associated dunes from pipeline emplacements, navigation channel use and dredging, and construction or continued use of infrastructure in support of a proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 gas processing plants and 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of non-intrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities. Maintenance dredging of barrier inlets and bar channels is expected to occur, which, combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which would accelerate erosion in those areas. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

4.2.2.1.3.2. Wetlands

This section considers impacts from a proposed action in the CPA to coastal wetlands and marshes. The primary impact-producing activities associated with a proposed action that could affect wetlands and marshes include pipeline emplacement, construction and maintenance, navigation channel use (vessel traffic) and maintenance dredging, disposal of OCS-related wastes, and use and construction of support infrastructure in these coastal areas. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigational traffic, levee construction that prevents necessary sedimentary processes, saltwater intrusion that changes the hydrology leading to unfavorable conditions for wetland vegetation, and vulnerability to storm damage from eroded wetlands. The following sections describe the sources and types of these potential impacts.

Wetland loss rates in coastal Louisiana are well documented to have been as high as 10,878 ha/yr (42 mi^2/yr) during the late 1960's. Studies have shown that the landloss rate in coastal Louisiana for the period 1972-1990 slowed to between an estimated 6,475 ha/yr (25 mi^2/yr) (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993) and 9,072 ha/yr (35 mi^2/yr) (USDOI, GS, 1998). It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 2,672 ha/year (10 mi^2/yr) over the next 50 years. Further, it was estimated that an additional net loss of 132,794 ha (512 mi^2) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al., 2003). However, in 2005 Hurricanes Katrina and Rita caused 217 mi^2 of land change (primarily wetlands to open water) (Barras, 2006). The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and shifted the coastal area from a condition of net land building to one of net landloss (USACOE, 2004c).

Pipeline Emplacement

As of July 2006, there were more than 45,000 km (27,962 mi) of pipelines in Federal offshore lands, and about 15,400 km (9,569 mi) of OCS pipelines extend into State waters and onshore. Many OCS pipelines make landfall on Louisiana's barrier island and wetland shorelines. Approximately 8,000 km (4,971 mi) of OCS-related pipelines cross marsh and uplands (Johnston and Cahoon, in preparation). Louisiana wetlands protect pipelines from waves and ensure that the lines stay buried and in place (also see **Chapter 4.1.2.1.7,** Coastal Pipelines). Existing pipelines, especially those installed prior to the State of Louisiana Coastal Permit Program in 1981, have caused direct landloss averaging between 2.5 ha/km (10 ac/mi) (Bauman and Turner, 1990) and 4.0 ha/km (16 ac/mi) (Johnston and Cahoon, in preparation) of linear pipeline. Bauman and Turner (1990) indicated that widening of OCS pipeline canals does not appear to be an important factor for total net wetland loss in the coastal zone because few pipelines are open to navigation (see cumulative impacts in **Chapter 4.5.3.2)**.

Since 2002, only one new pipeline has come to shore in Louisiana from OCS-related activities. In 2003, the 30-in Endymion Oil Pipeline, which delivers crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field, was installed. Based on a review of the data in the COE permit application (No. 20-020-1632), the emplacement of the pipeline caused zero (0) impacts to marshes (emergent wetlands) and beaches because the operator used horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the pipeline route maximized an open-water route to the extent possible (a comprehensive description of current mitigative measures is discussed in **Chapter 4.5.3.2**). A comparison of aerial photos taken before and after Hurricanes Katrina and Rita reveal no observable landloss or impacts associated with the Endymion Oil Pipeline.

Dredging

The COE, New Orleans District (NOD) annually removes approximately 90 million yd^3 of dredged material from 10 Federal navigational channels throughout coastal Louisiana. Approximately 27 million yd^3 (25-35%) of this material is used for coastal wetland restoration projects (Creef and Mathies, 2002). As a result of the tremendous wetlands landloss in the Louisiana coastal region, the beneficial use of dredge spoils is expected to increase. Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (**Chapter 4.1.2.1**). Given the "mission statement" of the COE, which requires it to take environmental impacts into consideration during its decisionmaking processes, increased emphasis has been placed on the use of dredged material for marsh creation.

Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels deposits material on existing dredged-material disposal banks and disposal areas; the effects of dredged-material disposal banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor exacerbation of existing problems. Typically, some dredged material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging will also temporarily increase turbidity levels in the vicinities of the dredging and disposal of materials, which can impact emergent wetlands, seagrass communities, and associated habitats.

Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) a hydraulic cutterhead suction dredge transfers sediments via connecting pipelines; and (2) a clamshell bucket dredge transfers sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to the dredged-material disposal site. Coarser sediment settles to the bottom where it spreads outward under the force of gravity; finer sediments may remain in suspension longer. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area. The dredged sediments are released into the area specified for disposal. This method usually produces positive relief features in the placement area.

Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged materials (Rozas, 1992). Placement of this material alongside canals converts marsh to upland, an environment unavailable to aquatic organisms except during extreme tides. Dredge material can also form a barrier causing ponding behind levees and limiting circulation between canal waters and marshes to infrequent, high-water events (Swenson and Turner 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Kuhn et al., 1999; Turner et al., 1994; Rozas, 1992; Turner and Cahoon, 1988).

Navigational Channels and Vessel Traffic

Vessel traffic that may support a proposed action is discussed in **Chapter 4.1.1.8.4**. Navigation channels projected to be used in support of a CPA proposed action are discussed in **Chapter 4.1.2.1.9**. Navigation channels that support the OCS Program are listed in **Table 3-36**.

Approximately 3,200 km (1,988 mi) of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf, exclusive of channels through large bays, sounds, and lagoons. About 700 km (435 mi) of these channels are found around the WPA; another 2,000 km (1,243 mi) is found in the CPA. No new navigational channels are expected to be dredged/constructed as a result of a proposed action in the CPA. Deepwater activities are anticipated to increase, requiring use of larger service vessels for efficient operations. This may put a substantial emphasis on shore bases associated with deeper channels. Some of the ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand the port infrastructure to accommodate these deeper-draft vessels. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. At present, the entrance to Port Fourchon (Belle Pass Channel) is maintained at 29 ft. The inland channel in the port is 26 ft and Bayou Lafourche is maintained at 24 ft. The FEMA has funded the dredging of several sites that were silted by Hurricanes Katrina and Rita.

According to Turner and Cahoon (1988), navigation channels have caused at least 17,000 ha (42,008 ac) of habitat change in coastal Louisiana. Of that total, about 13,700 ha (81%) of direct wetland loss were caused by the Mississippi River Gulf Outlet (MRGO), Calcasieu Ship Channel, and Beaumont Channel/Sabine Pass, all of which have very low OCS destination usage (see **Chapter 4.5.3.2**, Cumulative Impacts).

Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion processes. Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Louisiana coast. According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr (8.46 ft/yr), compared with 0.95 m/yr (3.12 ft/yr) for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr (4.9 ft/yr), or 300 ha (741 ac) of landloss per year for the 2,000 km (1,243 mi) of OCS-related navigation channels in the CPA.

Disposal of OCS-Related Wastes

Produced sands, oil-based or synthetic-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities will be transported to shore for disposal. Sufficient disposal capacity exists at the disposal site near Lacassine, Louisiana (EIA LA-1) and at other disposal sites under development or projected for future development in Subareas LA-1, LA-2, and MA-1 (**Chapter 4.1.2.1.6**). Discharging OCS-related produced water into inshore waters has been discontinued. All OCS-produced waters are discharged into offshore waters in accordance with NPDES permits or transported to shore for injection. Produced waters are not expected to affect coastal wetlands (**Chapter 4.1.1.4.2**).

Because of wetland protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in **Chapter 4.1.2.1** and **Table 4-9**. State and Federal permitting agencies discourage the placement of new facilities and the expansion of existing facilities in wetlands. Any impacts upon wetlands are mitigated. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to a proposed action.

Proposed Action Analysis

Zero to one pipeline landfalls resulting in up to 2 km (1.2 mi) of onshore pipeline are projected as a result of a proposed action in the CPA. Should one be constructed, it will most likely be in Louisiana, where the large majority of the infrastructure exists for receiving oil and gas from the CPA. Such a landfall may occur through or in the immediate vicinity of coastal wetlands and marshes. Wherever a landfall occurs, permitting processes are sequenced to ensure wetlands are protected first through avoidance, then minimization of impacts, and finally compensation for unavoidable impacts to wetlands. The use of modern technologies, such as directional boring, greatly reduces and perhaps eliminates impacts to coastal wetlands and marshes. About 5-8 ha (12-20 ac) of landloss for the projected 2 km (1.2 mi) of pipeline (based on historic loss rates cited above) are expected from a proposed action in the CPA. This represents approximately 0.25 percent of the total landloss estimated to occur along the Louisiana coast in 1 year (~2,590 ha or 10 mi^2 according to Barras et al., 2003). This estimate does not take into account the present regulatory programs of the COE and Louisiana DNR, modern installation techniques, and "no net loss" policy, which would result in zero (0) to negligible impacts to wetland habitats. Therefore, effects on coastal wetlands and marshes from new pipeline laying activities associated with a proposed action in the CPA are expected to be minor or nonexistent. These impacts are considered to be negligible.

For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

On average, 12 percent of traffic using OCS-related navigation channels is related to the OCS Program, and a proposed action is expected to contribute 2-3 percent to this usage. The roughly 2,000 km (1,243 mi) of OCS-related navigation channels are expected to widen at approximately 1.5 m/yr (4.9 ft/yr). Based on percentage of use, a proposed action would thus contribute to about 0.6 ha (1.5 ac) of landloss per year. Therefore, impacts from vessel traffic related to a proposed action should remain minimal.

Because of wetland protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences. No effects to coastal wetlands from disposal of OCS-related wastes associated with a proposed action in the CPA are expected.

Summary and Conclusion

In summary, effects to coastal wetlands from the primary impact-producing activities associated with a proposed action in the CPA are expected to be low. Loss of 0-8 ha (0-20 ac) of wetlands habitat is estimated as a result of 0-2 km (0-1.2 mi) of new pipelines projected as a result of a proposed action. Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts; a proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. Vessel traffic associated with a proposed action is expected to contribute minimally to the erosion and widening of navigation channels and canals. Overall, impacts from these sources are expected to be low and could be further reduced through mitigation, such as horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Secondary impacts to wetlands would be primarily from vessel traffic corridors and will continue to cause approximately 0.6 ha (1.5 ac) of landloss per year.

4.2.2.1.3.3. Seagrass Communities

Seagrasses in the CPA are restricted to small shallow areas behind barrier islands in Mississippi and Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity, submerged seagrass beds are found inland and discontinuously throughout the coastal zone. Most beds of submerged aquatic vegetation located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Most submerged vegetation in this region usually remains submerged because of the micro-tidal regime of the northern Gulf. Only during extremely low, wind-driven tidal events would seagrass beds be exposed to the air. Even then, their roots and rhizomes remain buried in sediment. Activities that may result from a proposed action that could adversely affect submerged vegetation beds include pipeline construction, maintenance dredging of navigational channels, vessel traffic, oil spills, and spill response and cleanup. The potential impacts of oil spills and spill-response and cleanup activities are discussed in **Chapter 4. 3**.

Pipelines

The installation of 0-1 pipeline landfalls is projected as a result of a CPA proposed action (**Chapter 4.1.2.1.7**). Pipeline construction methods and disturbances are discussed in **Chapters 4.1.1.3.10.1 and 4.1.2.1.7**. Jetting of trenches for pipeline burial in water shallower than <200 ft (61 m) displaces sediments. The denser sediments fall out of suspension quickly; the finer sediments that decrease water clarity remain in suspension longer. Although the majority of materials resuspended by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and the density of the dredged materials.

Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Reduced water clarity can decrease plant density in the seagrass beds, which in turn can further increase turbidity as the root, thatch, and leaf coverage decreases (Wolfe et al., 1988). The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. As in maintenance dredging activities discussed below, activities from pipeline emplacement could reduce light, which is linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995).

The COE and State agencies take possible impacts to submerged vegetation into consideration during their review of pipeline permits. The permits for constructing pipelines require that turbidity impacts be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment. The permits also require surveying for locating beds of submerged vegetation, monitoring of turbidity and reporting to the COE and State agencies, and taking immediate action to correct turbidity problems.

Maintenance Dredging

No new navigational channels are expected to be dredged as a result of a proposed action or OCS Program activities in the CPA. Maintenance dredging schedules vary from yearly to rarely, and will continue indefinitely into the future. Deepwater activities are anticipated to increase, which will likely require greater use of larger service vessels for efficient operations and may cause greater use of shore bases associated with deeper channels.

Some of the ports that house OCS-related service bases and that can presently accommodate deeper-draft vessels have expanded their accommodations. (Service bases are discussed in **Chapter 4.1.2.1.1**) In coastal Louisiana, Port Fourchon has deepened the existing channels and has dredged additional channels to facilitate this expansion. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. At present, the entrance to Port Fourchon (Belle Pass Channel) is maintained at 29 ft. As part of its strategic plan for the future, the port is planning a new 50-ft channel (Falgout, personal communication, 2006c). A small portion of overall maintenance dredging would be attributable to a proposed action in the CPA.

Light attenuation is responsible for most landscape-level losses. The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. Reduced light has been linked to reductions of both seagrass cover and productivity (Orth and Moore 1983; Kenworthy and Haunert 1991; Dunton 1994; Czerny and Dunton 1995). Dredging has been determined to be one of the major causes of light reduction that results in changes in seagrass cover, composition, and biomass. Changes in species composition are usually the result of natural processes (i.e., succession), but they can be caused by moderation of salinity resulting from dredging and increased saltwater intrusion. Changes in species composition resulting from dredging activities may affect resource availability for some fish and waterfowl that use seagrass habitat as nursery grounds. Turbidity caused by maintenance dredging has been implicated in the decline of shoalgrass and increased bare areas in the lower Laguna Madre (Onuf, 1994) located behind the south Texas barrier islands.

Vessel Traffic

Navigation traffic that may support a proposed action is discussed in **Chapter 4.1.2.1.9**. Most navigation channels projected to be used for the CPA proposed actions are shallow and currently used by vessels that support the OCS Program (**Table 3-36**). For example, the GIWW is dredged to 4 m, but it is actually about 5.5 m (18.0 ft) deep between the Pascagoula Channel and the Bayou LaBatre Channel and generally about 3.7 m (12.1 ft) deep between the Bayou LaBatre and Mobile Bay Channels. Prop wash of shallow navigation channels by vessel traffic dredges up and resuspends sediments, increasing the turbidity of nearby coastal waters. Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors.

Proposed Action Analysis

Pipelines

All of the gas production and most of the oil production from a CPA proposed action is expected to be mingled in pipelines with other OCS production at sea before going ashore. Seagrasses are not present in the Federal OCS waters where most of the length of any pipeline supporting a proposed action would be installed. For a proposed action in the CPA, any pipelines that made landfall would most likely go ashore in Mobile County, Alabama; Jackson County, Mississippi; or Plaquemines Parish, Louisiana. Many sparse and scattered beds of seagrasses and other submerged vegetation are found around the islands of these counties and parishes. Seagrasses are also associated with the Chandeleur and Breton Islands, through which a pipeline might pass on its way to make a landfall in Plaquemines Parish, Louisiana, or to link up with an existing pipeline. Although the majority of materials dredged by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Permit requirements of the COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation, if implemented (**Chapter 4.1.2.1.7**). Hence, significant direct impacts to submerged vegetation by pipeline installation are expected to be very small and short term if they occur.

Maintenance Dredging

Denser dredged materials fall out of suspension quickly; less dense sediments settle to the water bottom slowly. These lighter bottom sediments are generally more easily resuspended by storms than were the original surface sediments. Therefore, for a period of time after dredging occurs, water turbidity will be greater than usual in the vicinity of the dredging. With time, this reoccurring, increased turbidity will decrease to pre-project conditions, as the lighter materials are either dispersed to deeper water by currents, where they are less available for resuspension, or they are consolidated into or under denser sediments.

For estuarine species that thrive in salinities of about 0.5-25 ppt, this elevated turbidity may not pose a significant problem because they have adapted to turbid, estuarine conditions. However, it could be a problem for seagrass beds in higher salinities and for even freshwater submerged aquatic vegetation that require clearer waters. Significantly reduced water clarity or shading for longer than about 4 days will decrease chlorophyll production. If such conditions continue for longer than about 2 weeks, plant density in the bed will begin to decrease. If plant density reduces significantly, further increases in turbidity will occur as the root, thatch, and leaf coverage decline.

Because much of the dredged material resulting from maintenance dredging will be placed on existing dredged-material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging related to a proposed action. While increased dredging in the Port Fourchon area may result, in part, due to a proposed action, seagrass beds are not commonly found in that area. The area around Fourchon, Louisiana, typically has highly turbid waters that do not support the growth of seagrass beds. Maintenance dredging for inshore navigational canals is only partly related to the proposed action. Dredging regulations by the COE and coastal States are designed to protect seagrass beds from impacts by maintenance dredging. Adherence to coastal regulations is expected to limit impacts on seagreass resources to a low level.

Vessel Traffic

Most of the navigation channels to be used in support of proposed action activities are shallow, therefore allowing for possible impacts to associated seagrass and submerged vegetation from propeller scarring and resuspension of sediments from propwash. Navigational traffic through the GIWW between the Bayou LaBatre Channel and Mobile Bay Channel would resuspend sediments. A proposed action would contribute to a percentage of traffic through that stretch. However, beds of submerged vegetation within the area of influence of that channel and other channels have already adjusted their configurations in response to turbidity generated there.

Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors. Vessel captains may cut corners of channel intersections or navigate across open water where they may unexpectedly encounter shallow water where beds of submerged aquatic vegetation may occur. Propellers may damage a bed superficially by leaving a few narrow cuts. Damage may be as extensive as broadly plowed scars from the keel of a large boat accompanied by extensive prop washing; trampling by waders; and additional keel, prop, and propwash scars left by other vessels that assisted in freeing the first boat.

Summary and Conclusion

Most seagrass communities located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat (discussed in **Chapters 4.3.1.8 and 4.4.2.3**).

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Hence, impacts to submerged vegetation by pipeline installation are projected to be very small and short term.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a navigation channel's area of influence will have already adjusted their bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area or damage to an already stressed area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a CPA proposed action and increased dredging is expected in an area that does not normally support seagrass beds.

4.2.2.1.4. Impacts on Sensitive Offshore Benthic Resources

4.2.2.1.4.1. Continental Shelf Benthic Resources

4.2.2.1.4.1.1. Live Bottoms (Pinnacle Trend)

Seventy blocks are within the region defined as the pinnacle trend, which contains live bottoms that may be sensitive to oil and gas activities. These blocks are located in the northeastern portion of the CPA, and are located between 60- and 120-m (197- and 394-ft) water depths in the Main Pass and Viosca Knoll lease areas. Leases in past sales have contained a live-bottom stipulation to protect such areas. The proposed Live Bottom (Pinnacle Trend) Stipulation is presented in **Chapter 2.4.1.3.2** as a potential mitigating measure for leases resulting from a proposed action. The stipulation is designed to prevent drilling activities and anchor emplacement (the major potential impacting factors on these live bottoms resulting from offshore oil and gas activities) from damaging the pinnacles. Under the stipulation, both EP and DOCD plans will be reviewed on a case-by-case basis to determine whether a proposed operation could impact a pinnacle feature. If it is determined from site-specific information derived from MMS studies, published information from other research programs, geohazards survey information, or another source that the operation would impact a pinnacle feature, the operator will be required to relocate the proposed operation. Although the Live Bottom Stipulation is regarded as a highly effective protection measure, infrequent accidental impacts are possible. Accidental impacts may be caused by operator positioning errors or when studies and/or geohazards information are inaccurate or fail to note the presence of pinnacle features. One such incident has been documented and is discussed in further detail below. While investigating sites of previous oil and gas drilling activities, Shinn et al. (1993) documented that a lease operator had located an exploratory well adjacent to a medium-relief pinnacle feature; the reason for this occurrence is still undetermined. In spite of this documented instance, the stipulation is still considered effective since it allows MMS flexibility to request any surveys or monitoring information necessary to ensure protection of these sensitive areas. The impact analysis presented below is for a typical proposed action in the CPA and includes the proposed Live Bottom (Pinnacle Trend) Stipulation.

A number of OCS-related factors may cause adverse impacts on the pinnacle trend communities and features. Damage caused by anchoring, infrastructure and pipeline emplacement, infrastructure removal, blowouts, drilling discharges, produced-water discharges, the disposal of domestic and sanitary wastes, and oil spills can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible. Impacts from oil spills and blowouts are discussed in **Chapter 4.4.4.1.1**.

Anchoring may damage lush biological communities or the structure of the pinnacles themselves, which attract fish and other mobile marine organisms. Anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels greatly disturb areas of the seafloor and are the greatest threats to live-bottom areas at these depths. The size of the affected area would depend on water depth, anchor and chain sizes, chain length, method of placement, wind, and current. Anchor damage includes, but is not limited to, crushing and breaking of the pinnacles and associated communities. Anchoring often destroys a wide swath of habitat by being dragged over the seafloor, or the vessel swings at anchor, causing the anchor chain to drag the seafloor.

The emplacement of infrastructure, including drilling rigs and platforms, on the seafloor will crush the organisms directly beneath the legs or mat used to support the structure. The areas affected by the placement of the platforms and rigs are predominantly soft-bottom regions where the infaunal and epifaunal communities are not unique in waters less than 61 m (200 ft). Pipeline emplacement directly affects the benthic communities through burial and disruption of the benthos and through resuspension of sediments. These resuspended sediments may obstruct filter-feeding mechanisms and gills of fishes and sedentary invertebrates.

Both explosive and nonexplosive structure removal operations will disturb the seafloor and potentially affect nearby pinnacle communities. Structure removal using explosives (the most common removal method in these water depths) will suspend sediments throughout the water column impacting the nearby habitats. Deposition of these sediments will occur much in the same manner as discussed for muds and cuttings discharges (**Chapter 4.1.1.4.1**). Explosive structure removals create shock waves, which also harm resident biota in the immediate vicinity. O'Keeffe and Young (1984) have described the impacts of underwater explosions on various forms of sea life. They found that sessile organisms of the benthos (such as barnacles and oysters) and many motile forms of life (such as shrimp and crabs) that do not possess swim bladders are remarkably resistant to the blast effects from underwater explosions. Organisms not in the immediate blast area should survive. Benthic organisms would be further protected from the impacts of explosive detonations by the rapid attenuation of the underwater shock wave through the seabed. The shock wave attenuation is significantly greater in mud than in the water column, where it is known to impact fish up to 60 m (197 ft) away from an 11.3-kg charge detonated at a 100-m (328-ft) depth (Baxter et al., 1982).

Drilling discharges can affect biological communities and organisms by mechanisms such as the smothering or choking of organisms through deposition of discharged materials and the less obvious sublethal toxicological impacts (e.g., depressed growth and reproduction). During oil and gas drilling operations, the discharged drilling muds and cuttings cause turbidity and literally choke the benthos in close proximity to the drill site. Shinn et al. (1993) surveyed the exploratory well site erroneously located immediately adjacent to a 4-5 m (13-16 ft) high pinnacle feature, located at a 103 m (338 ft) depth. Cuttings and drill debris were documented within 6,070 m^2 (1.5 ac) surrounding the drill site. In spite of being inundated by drill muds and cuttings 15 months prior to the investigation, the pinnacle feature was found to support a diverse community, which included gorgonian or soft corals, sponges, non-reef-building corals, a species of horn coral, and abundant meter-long whiplike antipatharians characteristic of tropical hard-bottom communities in water 30 m (98 ft) or more in depth. Shinn et al. (1993) concluded the following: "Gorgonians, antipatharians, crinoids, and non-reef-building corals attached to the pinnacle feature adjacent to the drill site as well as nearby rock bottom did not appear to be affected."

Shinn et al. (1993) acknowledged that their evaluation of the drill site was constrained both by the lack of baseline data on the live-bottom community prior to inundation by drilling discharges and by the need for a study on long-term changes (e.g., 10 years). Continental Shelf Associates (CSA) and Texas A&M University, Geochemical and Environmental Research Group (2001) suggest that recovery of hard-bottom communities following a disturbance will be slow. Hard-bottom communities studied during the Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring Program exhibit a dynamic sedimentary environment with relatively little net growth of the epibiota associated with the pinnacle features. Additionally, epibiont recruitment studies performed during this same survey showed relatively slow development of fouling community constituents on recruitment plates. Basically, only the earliest successional stages were observed by the end of the study (27 months of exposure), and the epibiota typically associated with nearby hard-bottom features were rare on the plates. It is not known whether the results would have differed if the substrate had consisted of exposed patches of natural hard bottom; however, analysis of larger substrates such as artificial reefs exposed for months to several years also indicates slow community development (Marine Resources Research Institute, 1984). Drilling discharges are still considered to have a deleterious impact on the live-bottom communities of the pinnacle trend, and the stipulation will continue to be applied to minimize the possibility of similar occurrences.

Produced water, described in detail in **Chapter 4.1.1.4.2**, usually contains high amounts of dissolved solids and total organic carbon, and low amounts of dissolved oxygen. Other common components include heavy metals, elemental sulfur and sulfide, organic acids, treating chemicals, and emulsified and particulate crude oil constituents. Salinity of produced water can vary from 0 to 300 ppt. The constituents of produced water have the potential to adversely impact the live-bottom organisms of the pinnacle trend if the constituents reach them in high enough concentrations. Domestic and sanitary wastes originate from sinks, showers, laundries, and galleys, as well as waste water from safety showers, eye-wash stations, and fish-cleaning stations. Human wastes, which contain fecal coliform bacteria, are treated by approved marine sanitation devices prior to discharge. A more complete description of domestic and sanitary wastes can be found in **Chapter 4.1.1.4.6**. The proposed Live Bottom Stipulation would prevent the placement of oil and gas facilities upon the pinnacle trend and live-bottom areas. Consequently, the stipulation prevents the discharge of produced water and domestic and sanitary wastes from occurring directly on top of the live-bottom areas. Dispersion of these wastes should occur rapidly (less than 24 hours) upon discharge.

Proposed Action Analysis

The pinnacles in the CPA are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama within offshore Subareas C0-60 (east of the Mississippi River Delta) and C60-200. **Table 4-3** provides information regarding the level of proposal-related activities.

For a CPA proposed action, 77-138 exploration/delineation and development wells and 7-11 production structures are projected for offshore Subareas C0-60 east of the Mississippi River and C60-200. It is unlikely that many of the wells or production structures would be located in the pinnacle trend area, because pinnacle blocks make up only 2 percent of the blocks in Subarea C0-60 (eastern) and 6 percent of the blocks in Subarea C60-200. If the Live Bottom Stipulation is implemented, pinnacle features would incur few incidences of anchor damage from support vessels. Furthermore, as noted above, any platforms in this region would be placed so as to avoid pinnacle features for safety reasons as well as environmental protection. Thus, anchoring events are not expected to impact the resource. Accidental anchor impacts, however, could occur, with recovery taking 5-10 years, depending on the severity. No such accidents have been recorded to date.

Pipeline emplacement also has the potential to cause considerable disruption to the bottom sediments in the vicinity of the pinnacles (**Chapter 4.1.1.8.1**); however, the implementation of the proposed Live Bottom Stipulation, or a similar protective measure, would restrict pipeline-laying activities as well as oil and gas activities in the vicinity of the pinnacle communities. Data gathered for the Mississippi-Alabama Continental Shelf Ecosystem Study (Brooks, 1991) and the Mississippi/Alabama Pinnacle Trend

Ecosystem Monitoring, Final Synthesis Report (Continental Shelf Associates, Inc. and Texas A&M University, Geochemical and Environmental Research Group, 2001) document dense biological communities (i.e., live-bottom communities, fish habitat, etc.) on the high- and medium-relief pinnacle features themselves and live-bottom organisms more sparsely distributed in unconsolidated bottom sediments surrounding the pinnacles. The actual effect of pipeline-laying activities on the biota of the pinnacle communities would be restricted to the resuspension of sediments. Burial of pipelines is only required in water depths of 60 m (200 ft) or less. Therefore, only the shallowest pinnacles would be affected by the increased turbidity associated with pipeline burial. The laying of pipeline without burial produces much less resuspension of sediments. The enforcement of the Live Bottom Stipulation will help to minimize the impacts of pipeline-laying activities throughout the pinnacle region. As previously stated, few pipelines in the vicinity of the pinnacle trend are projected to result under a proposed action. The severity of these actions has been judged at the community level to be slight, and impacts from these activities to be such that there would be no measurable interference to the general ecosystem.

Oil and gas operations discharge drilling muds and cuttings that generate turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings in the pinnacle trend area would not greatly impact the biota of the pinnacles or the surrounding habitat. The biota of the seafloor surrounding the pinnacles are adapted to turbid (nepheloid) conditions and high sedimentation rates associated with the outflow of the Mississippi River. The pinnacles themselves are coated with a veneer of sediment. Regional surface currents and water depth would largely dilute any effluent. Additional deposition and turbidity caused by a nearby well are not expected to adversely affect the pinnacle environment because such fluids would be discharged into very large volumes of water and would disperse. Mud contaminants measured in the pinnacle trend region reached background levels within 1,500 m (4,921 ft) of the discharge point (Shinn et al., 1993). Toxic impacts on benthos are limited to within 100 m (328 ft) as a result of the NPDES permit requirements. Such an event would rarely impact the pinnacle trend, live-bottom communities.

The toxicity of the discharged produced waters and domestic and sanitary wastes has the potential to adversely impact the live-bottom organisms of the pinnacle trend; however, as previously stated, the proposed Live Bottom Stipulation would prevent the placement of oil and gas facilities upon (and consequently would prevent the discharge of produced water and domestic and sanitary wastes directly over) the pinnacle trend, live-bottom areas.

Platform removals have the potential to impact nearby habitats. As previously discussed, the platforms are unlikely to be constructed directly on the pinnacles because of the restraints placed by the Live Bottom Stipulation. Structure removal activities should not deleteriously impact the pinnacle trend area considering the following:

- benthic organisms are resilient to blasts, so only restricted regions would be affected by shock waves from explosives;
- the resuspension of sediments would be limited both in time and space (24 hr for the water column 4 m off the bottom and above, and 7-10 days for the water layer contained in the first 4 m off the seafloor; resuspension of sediments would extend about 1,000 m (3,281 ft) away from the blasts);
- only a few structures would be removed (2 anticipated removals in the pinnacle area); and
- structures to be removed would have been placed away from any sensitive resources.

Summary and Conclusion

Activities resulting from a proposed action in the CPA are not expected to impact adversely the pinnacle trend environment because of implementation of the Live Bottom Stipulation. No community-wide impacts are expected. The inclusion of the Live Bottom Stipulation would minimize the potential for mechanical damage. The impacts of a proposed action are expected to be infrequent because of the few operations in the vicinity of the pinnacles and the small size and dispersed nature of many of the features. Potential impacts from blowouts, pipeline emplacement, mud and cutting discharges, and structure removals would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features. Impacts from accidents involving anchor placement on pinnacles (those actually crushed or subjected to abrasions) could be severe where they occur.

Effects of the Proposed Action without the Proposed Stipulation

Activities resulting from a proposed action without the protection of the proposed Live Bottom (Pinnacle Trend) Stipulation (**Chapter 2.4.1.3.2**) could have an extremely deleterious impact on portions of the pinnacle trend. Mechanical damage from anchoring, drilling operations, and other activities is potentially the most damaging impact because these activities could destroy biological communities or damage the structure of the pinnacles themselves, reducing the habitat or shelter areas occupied by commercial and recreational fishes. The unevenness of the seafloor associated with the larger pinnacle features would reduce the likelihood that rigs or platforms would be placed directly over a pinnacle. In addition, the pinnacles are widespread throughout the region, so that the potential loss of a few features (or areas within a feature) would cause only slight community-wide impacts on the pinnacle trend as a whole. Because of the low levels of projected OCS activities in the pinnacle trend area and the small size of many features, occurrences of damage would be infrequent. Those areas actually subjected to mechanical disruption would be severely impacted, however. Potential impacts on the pinnacle trend, live-bottom areas from other impact-producing factors associated with OCS activities (pipeline emplacement, discharges of muds and cuttings, explosive structure removals, and oil spills and blowouts) would be infrequent because of the low projected levels of OCS activities. In addition, the widespread occurrence of these pinnacles would further restrain these impacts.

4.2.2.1.4.1.2. Topographic Features

The topographic features sustaining sensitive offshore habitats in the CPA are listed and described in **Chapter 3.2.2.1.2**. A Topographic Features Stipulation similar to the one described in **Chapter 2.4.1.3.1** has been included in appropriate leases since 1973 and may, at the option of the Secretary, be made a part of appropriate leases resulting from this proposal. The impact analysis presented below for a proposed action in the CPA includes the proposed biological lease stipulation. As noted in **Chapter 2.4.1.3.1**, the stipulation establishes a No Activity Zone within which no bottom-disturbing activities would be allowed and areas around the No Activity Zones (in most cases) within which shunting of drill cuttings and drilling fluids to near the bottom would be required.

The potential impact-producing factors on topographic features of the Central Gulf are anchoring (**Chapter 4.1.1.3.3.1**), infrastructure emplacement (**Chapter 4.1.1.3.2**), drilling-effluent and produced-water discharges (**Chapter 4.1.1.4.2**), and infrastructure removal (**Chapter 4.1.1.11**). Impacts from oil spills and blowouts are discussed in **Chapter 4.4.4.1.2**. These disturbances have the potential to disrupt and alter the environmental, commercial (fisheries), recreational, and aesthetic values of topographic features in the CPA.

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be the greatest threat to the biota of the offshore banks in the Gulf (Bright and Rezak, 1978; Rezak et al., 1985). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the Topographic Features Stipulation.

Infrastructure emplacement and pipeline emplacement are other oil and gas activities that could resuspend sediments. The proposed stipulation would also prevent these activities from occurring in the No Activity Zone, thus preventing most of these resuspended sediments from reaching the biota of the banks. The Topographic Features Stipulation requires all bottom-disturbing activity to be at least 152 m (500 ft) away from the boundaries of No Activity Zones.

Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (10,542 bbl/exploratory well; 7,436 bbl/development well) (USEPA, 1993a and b), potential impacts on biological resources of topographic features should be expressly considered if drill sites occur in blocks directly adjacent to No Activity Zone boundaries. Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants. The USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone. **Chapters 4.1.1.4.1 and 4.2.2.1.2** detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and extent measured in the past because current USEPA regulations and NPDES permits contain more restrictive limits (**Chapter 4.2.1.3.2**). The effects of past muds and cutting discharges are also discussed in **Chapter 4.2.1.3.2**. A brief overview of the potential impacts on topographic features by drilling discharges follows.

Water-column turbidity and the smothering of sessile invertebrates on topographic features caused by drilling muds and cuttings are of little significance for two reasons. First, the Topographic Features Stipulation limits impact through the No Activity Zone and shunting restrictions imposed within the 1-Mile Zone, 3-Mile Zone, 4-Mile Zone, and 1,000-Meter Zone, as well as the USEPA general NPDES permit special restrictions on discharge rates in blocks adjacent to a No Activity Zone or sensitive areas, which necessitates photodocumentation by industry. Secondly, studies have shown the rapid dispersion of drilling fluid plumes in the OCS within a 1,000-m (3,281 ft) range of the discharge point and the resilience of sessile invertebrates exposed or smothered with an extreme range of concentrations of drilling muds (Kendall, 1983). For local accumulation of contaminants, assumptions are that trace-metal and petroleum contamination resulting from drilling muds and cuttings will occur mainly within a few hundred to a couple of thousand meters downcurrent from the discharge point and can be found up to 3,000 m (9,842 ft) downcurrent in shallow waters. Concentrations of contaminants decrease with an increasing distance from the drilling site. By examining sediments surrounding three gas production platforms (within a 100-m (328-ft) radius), Kennicutt et al. (1996) found low concentrations of petroleum and trace metal contaminants that would be unlikely to induce a biological response in benthic organisms. The highest trace metal concentrations originating from discharged drilling fluids and found around platforms were strongly correlated with the presence of sand-size sediments. Shallow sites are subject to comparatively greater sediment removal and resuspension because of a high-energy environment. Contaminants from previous discharges under less restrictive conditions have been found to remain in sediments surrounding drill sites for as long as 10 years (Kennicutt et al., 1996). Toxic effects could be incurred by benthic organisms on topographic features found in the vicinity of a No Activity Zone boundary if the plume flow of an operation is consistently directed toward that boundary. Should effects occur, they would potentially persist for as long as 10 years following the cessation of discharges.

Produced waters could also represent a significant potential source of impact to the biota of topographic features, considering produced water constitutes the largest single discharge during routine oil and gas operations. The USEPA general NPDES permit restrictions on the discharge of produced water help to limit the impacts on biological resources of topographic features. Past evaluation of the bioaccumulation of offshore produced-water discharges conducted by the Offshore Operators Committee (1997) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals (2 species of molluscs and 5 species of fish). Because high-molecular, polycyclic aromatic hydrocarbons (PAH's) are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers. A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in **Chapter 4.2.2.1.2**.

The impacts of structure removal on topographic features can include water turbidity, sediment deposition, and explosive shock-wave impacts. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity. The deposition of resuspended sediments would occur much in the same manner as discussed for discharges of muds and cuttings, choking and causing mortality of sessile benthic organisms. Turbidity could both reduce light levels and obstruct filter-feeding mechanisms, leading to reduced productivity, susceptibility to infection, and mortality. The shock waves produced by the explosive structure removals could also harm associated biota. Corals and other sessile invertebrates have a high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m away from the detonation of 135-kg (298 lb) charges in open water incurred a 5 percent mortality. Crabs distanced 8 m away from the explosion of 14-kg (31 lb) charges in open water had a 90 percent mortality rate. Few crabs died when the charges were detonated 46 m (151 ft) away. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock-wave is significantly attenuated in mud compared with in the water column where it is known to impact fish up to 60 m (197 ft) away from a 11.3-kg charge blasted at a 100-m (328-ft) water depth (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m (15 ft) below the seabed as required by MMS regulations would further attenuate blast effects (Wright and Hopky, 1998). However, recent evidence shows that attenuation of blast effects is dependent on sediment characteristics. Reliable determination of blast effects must be from *in situ* measurements or modeling based on sediment characteristics. In the absence of these methods, environmental impact evaluations should be based on attenuation equivalent to charges detonated on the bottom in open water (CSA, 2004). Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Programmatic Environmental Assessment for Structural Removal Activities* (USDOI, MMS, 1987) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the Gulf of Mexico. Impacts on the biotic communities, other than those on or directly associated with the platform, would be limited by the relatively small size of individual charges (normally 22.7 kg (50 lb) or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m (15 ft) below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive). The stipulation discussed above would preclude platform installation within 152 m (500 ft) of the No Activity Zone, thus preventing adverse effects from nearby removals.

Proposed Action Analysis

Of the 16 topographic features (shelf edge banks, mid-shelf banks, and low-relief banks) in the CPA, 15 are found in waters less than 200 m (656 ft) deep. Geyer Bank is located at a depth of 190-210 m (623-689 ft). They represent a small fraction of the Central Gulf area.

As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements, anchoring activities, and removals. Yet, operations outside the No Activity Zones could still affect topographic features through drilling-effluent and produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in **Chapter 4.4.4.1.2**.

For a CPA proposed action, 108-126 exploration/delineation and development wells are projected for offshore Subareas C0-60 and C60-200. With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zones. Drilling discharges would be shunted to within 10 m (33 ft) of the seafloor either within a the 1,000-Meter Zone, 1-Mile Zone, 3-Mile Zone, or 4-Mile Zone (depending on the topographic feature) around the No Activity Zone (see **Chapter 2.4.1.3.1** for details). This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It has been estimated, however, that drilling effluents and produced waters could reach and impact topographic features 5-10 times during the life of this proposal. The severity of such impacts would probably be primarily sublethal such that there may be a disruption or impairment of a few elements at the regional or local scale, but no interference to the general system performance. Recovery to pre-impact conditions should take place within 2 years.

For a CPA proposed action, 22-24 production structures are projected in offshore Subareas C0-60 and C60-200. There are 12 structure removals using explosives projected for Subarea C0-60 and 2 for Subarea C60-200. The explosive removals of platforms should not impact the biota of topographic features because the Topographic Features Stipulation prohibits the emplacement of platforms within 152 m (500 ft) of the No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

Effects of the Proposed Action without the Proposed Stipulation

The topographic features and associated coral reef biota of the Central Gulf could be adversely impacted by oil and gas activities resulting from a proposed action in the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected Central Gulf topographic features.

The No Activity Zone would probably be the area of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Feature Stipulation and not followed up by mitigating measures. These impacting activities could include vessel anchoring and infrastructure emplacement, discharges of drilling muds and cuttings, and ultimately the explosive removal of structures. All of the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Such activities would physically and mechanically alter benthic substrates and their associated biota over areas, possibly ranging from tens to thousands of square meters per impact. Operational discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and interfering with larval settlement, resulting in the decrease of live benthic cover.

Finally, the unrestricted use of explosives to remove platforms installed near or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms caused by depositing foreign substances onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the 1,000-Meter Zone, 1-Mile Zone, and the 4-Mile Zone would definitely impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations within the 3-Mile Zone would be a further source of impact to the sensitive biological resources of the topographic features.

Therefore, in the absence of the Topographic Features Stipulation, a proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.2.2.1.4.2. Continental Slope and Deepwater Resources

4.2.2.1.4.2.1. Chemosynthetic Deepwater Benthic Communities

Physical

The greatest potential for adverse impacts on deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (**Chapter 4.1.1.3.8.1**), anchoring (**Chapter 4.1.1.3.3.1**), and structure emplacement (**Chapter 4.1.1.3.3**), as well as from an accidental seafloor blowout (**Chapter 4.4.4.2.1**). Potential impacts from blowouts are discussed in **Chapter 4.4.4.2.1**. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area.

Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. The presence of a conventional structure can also cause scouring of the surficial sediments by near-bottom ocean currents (Caillouet et al., 1981), although this phenomenon has not been demonstrated around structures in deep water.

Anchors from support boats and ships (or any buoys set out to moor vessels), floating drilling units, barges used for construction of platform structures, pipelaying vessels, and pipeline repair vessels also cause severe disturbances to small areas of the seafloor. The areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variety of prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy chemosynthetic communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the floating central drilling structure.

Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. Many oil and gas support operations involving ships and boats would not result in anchor impacts on deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or mooring buoys. In addition, there are drillships, construction barges, and pipelaying vessels operating in the GOM that rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and water currents. New technologies such as suction pile anchors could also limit the area impacted by the anchors themselves. Anchoring will likely destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for substrate as well as dispersion of hydrocarbon sources. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities.

Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha (0.79 ac) of bottom is disturbed per kilometer of pipeline installed). Since pipeline systems are not as established in deepwater as in shallow water, new installations are required, which will tie into existing systems or bring production directly to shore. Pipelines will also be required to transport product from subsea systems to fixed platforms.

In addition to physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cutting discussed below. In deep water, the probability that infrastructure will be left on the seabed is likely higher. As one example, the ConocoPhillips Joliet platform was the first tension leg platform (TLP) in the GOM and was installed in 1986 at a depth of 537 m in Green Canyon Block 184. The subsea template will be left in place after severing the tendons connecting the floating structure. This option will virtually eliminate all bottom-disturbing impacts. The well-studied Bush Hill is located only about 1.26 nmi from the TLP bottom template.

The impacts from bottom-disturbing activities directly on chemosynthetic communities are expected to be extremely rare because of the application of protective measures required by NTL 2000-G20. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering.

Discharges

In deep water, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Some information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m has been reported by Gallaway and Beaubien (1997). In this instance, a veneer of cuttings was observed scattered over the bottom, in some cases as thick as 20-25 cm (8-10 in). Chemical evidence of SBF components (used during this operation) was found at distances of at least 100 m (328 ft) from the well site (sampling distance was limited by the ROV tether length). Other information from a geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m (1,312 ft) water depths (Nunez, personal communication, 1994). At these sites, the areal coverage of cuttings was found extending from the previous well locations in splay or finger-like projections to a maximum of about 610 m, with an average of about 450 m (1,476 ft). An examination of side-scan-sonar records of these splays indicates that they were distributed in accumulations less than 30 cm (12 cm) thick.

A major new deepwater effects study funded by MMS was completed in 2006, *Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico* (CSA, 2006). This project included determinations of the extent of muds and cuttings accumulations resulting from both exploratory and development drilling at three sites in approximately 1,000 m (3,281 ft) of water. Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within the 500-m (1,640-ft) radius of what was termed near-field stations. A combination of a smooth seafloor (little backscatter on sidescan-sonar records) and a high amplitude response at the seafloor on high–resolution, subbottom profiles was used to identify areas of probable drilling mud deposition. Areas where sidescan sonar showed high reflectivity extending in a radial pattern around the well sites were interpreted as cuttings. Generally, areas mapped as drilling muds were identified within about 100 m (328 ft) of wellsites. Areas mapped as cuttings typically extended several hundred meters from well sites, with the greatest distance of about 1 km (0.6 mi) observed at two study sites. Geophysically mapped cuttings zones ranged from 13 to 109 ha (32 to 269 ac) in area, with larger zones observed at post-development sites.

Discretionary samples taken in likely mud/cuttings areas provided information about the thickness of mud and cuttings at a few stations. Sediment cores indicated accumulations of 2-4 cm (1-2 in) using concentrations of barium, total organic carbon, and lead 210 (^{210}Pb).

Impacts from muds and cuttings are also expected from two additional sources: (1) initial well drilling and installation of casing prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various dual-gradient or subsea mudlift drilling techniques in the deep sea. Pre-riser casing installation typically involves 36-in (91-cm) casing that may be set to a depth of 300 ft (91 m) and 26-in (66-cm) casing that may be set to a depth of 1,600 ft (488 m). Jetted or drilled cuttings from the initial wellbore could total as much as 226 m^3 (Halliburton Company, 1995). With dual-gradient drilling techniques, the upper portion of the wellbore will be "drilled" similar to conventional well initiation techniques with cuttings being discharged at the seafloor. After the BOP stack is installed, subsea mudlift pumps will circulate the drilling fluid and cuttings to the surface for conventional well solids control. Discharges from the dual-gradient drilling operations are expected to be similar to conventional drilling operations. Although the full areal extent and depth of burial from these initial activities are not known, the potential impacts are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater GOM, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

MacDonald et al. (1995) indicates that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube-worm and mussel communities may be more vulnerable than clam communities because clam communities are vertically mobile (preventing burial) and sparsely distributed. The primary concern related to muds and cuttings discharges is that of burial. Although chemosynthetic organisms thrive with some part of their anatomy located next to or inside of toxic and/or anoxic environments, all chemosynthetic megafauna (also including their symbiotic bacteria) also require oxygen to live. Complete burial by sediments or rock fragments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms (motile clams being one possible exception). Depending on the organism type, just a few centimeters of burial could cause mortality.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. Detrimental effects due to burial are expected to decrease exponentially in the same manner that the depths of accumulations of discharges decrease exponentially with distance from the origin. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. With the application of NTL 2000-G20, it is expected that no chemosynthetic communities would be located closer than 1,500 ft (457 m) from the surface location of any muds or cuttings discharges.

High-density, Bush Hill-type communities are areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long time intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. A long span of time is required for the precipitation of enough carbonate rock to support a large population of tube worms. As dense tube-worm communities require hard substrate as well as very active seepage at any point in space, existing communities covered by sediment that are physically damaged would likely never recover (Fisher, 1995).

Information is limited about the vulnerability of tube worms to sedimentation/smothering impact. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably, this burial occurs over long time intervals and may in large part be actual growth of the tube worm "root" into sediments in order to obtain required sulfide for the symbiotic bacteria's metabolism. Evidence of catastrophic burial of high-diversity chemosynthetic communities can be found in the paleo-record as documented by Powell (1995), but the importance of this in causing local extinctions was reported as minor. These burials were probably caused by catastrophic seismic events.

Methanotrophic mussel communities have strict chemical requirements that tie them directly to areas of the most active seepage. Physical disturbance of an active mussel bed is thought not to have a long-lasting effect on the community due to high growth rates of individuals (Fisher, 1995). Catastrophic mud burial would be one possible cause of a mussel community death. It is predicted that a mussel community completely eliminated by physical disturbance could be resettled and mature within 20 years.

Effluents from routine OCS operations (not muds or cuttings) in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m (328 ft).

Reservoir Depletion

There has been some speculation about the potential impact to chemosynthetic communities as a result of oil and gas withdrawal, causing a depletion of the energy source (hydrocarbons) sustaining the chemosynthetic organisms. There is evidence that both removal and reinjection of material into reservoirs that supply seeps on land in California affect the seepage rates. Quigley et al. (1996) reported evidence that suggested offshore California oil production resulted in reduced seepage due to reduction in reservoir pressure. The seeps and faults around which chemosynthetic animals live are supplied from the deep reservoirs that transport the gas or oil to the seafloor through combined effects of buoyancy and pressure. When all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 30% or less of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (less likely) stop.

Based on current information, it is not possible to determine whether reduced reservoir pressure would actually reduce the seepage (as observed onshore) or whether there may be enough oil already in the conduit to the surface to continue adequate levels of seepage for long periods, perhaps thousands of years or more. In the case of the well-studied Bush Hill community in Green Canyon Block 184, there has been no detectable change in community composition resulting from extraction of the hydrocarbon reserves by the nearby ConocoPhillips Joliet production field over the last 20 years. The Jolliet platform is scheduled to be removed in the near future after having extracted all economically recoverable hydrocarbons from the same source location that is connected to the Bush Hill community. The distribution of chemosynthetic communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients in either the near or distant future may potentially impact the type and distribution of the associated biological community.

Proposed Action Analysis

Because high-density chemosynthetic communities are generally found only in water depths greater than 400 m (1,312 ft), they would not be found in shallow-water areas of the CPA (offshore subareas C0-60 (western or eastern), C60-200 or C200-400, **Table 4-3**). Chemosynthetic communities could be found in the deeper water areas (offshore subareas C400-800, C800-1600, C1600-2400, and C>2400; **Table 4-3**). Of the 60+ known communities, all but approximately 10 of these chemosynthetic communities are known to exist in the CPA (**Figure 3-9**). The levels of projected impact-producing factors for deepwater offshore subareas C400-800, C800-1600, C1600-2400, and C>2400 are shown in **Table 4-3**. A range of 5-12 oil and gas production structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2007 and 2046 in the deepwater portions of the CPA as a result of a proposed action. These deepwater production structures are expected to be installed beginning in the third year and continue throughout the analysis period.

NTL 2000-G20 has been a measure for the protection of chemosynthetic communities since February 1, 1989. Now, NTL 2000-G20 makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NTL is exercised on all applicable leases and is not an optional protective measure. Under the provisions of this NTL, lessees operating in water depths greater than 400 m (1,312 ft) are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities; if such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities of the Bush Hill type. Requirements for specific separation distance between potential high-density chemosynthetic communities and both anchors (250-500 ft) and drilling discharge points (1,500 ft) have been included in the newest revision of the NTL. If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place in the area; if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid any areas that show the potential to support chemosynthetic communities. The basic assumptions underlying the provisions of this mitigation measure are (1) that dense chemosynthetic communities are associated with gas-charged sediments and oil or gas seeps, (2) that the gas-charged sediment zones or seeps have physical characteristics that will allow them to be identified by geophysical surveys, and (3) that dense chemosynthetic communities are not found in areas where gas-charged sediments or seeps are not indicated on the geophysical survey data. These assumptions have not been totally verified. A definitive correlation between the geophysical characteristics recorded by geophysical surveys and the presence of chemosynthetic communities has not been proven; however, the associations have proven to be very reliable in most all situations encountered to date, particularly on the upper continental slope.

Although there are limited examples of field verification, the requirements set forth in NTL 2000-G20 are considered effective in identifying potential areas of chemosynthetic communities. Although there has generally been compliance with NTL 2000-G20, compliance does not guarantee avoidance of high-density communities without visual confirmation in every case. On rare occasions, high-density chemosynthetic community areas may not be properly identified using the geophysical remote sensing and indicators specified in the existing NTL. The reliability of correlation between remote-sensing signatures and the presence of high-density communities may be reduced or different on the lower slope of the GOM. A new major study is beginning at the time of this writing (May 2006) specifically to investigate this concern. Funded by both MMS and NOAA Office of Ocean Exploration, this 4-year project will explore for and study chemosynthetic communities located deeper than 1,000 m (3,281 ft). As new information becomes available, the NTL will be further modified as necessary.

High-density, Bush Hill-type communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 2000-G20. A limited number of these communities have been found to date, but it is very probable that many additional communities exist. Observations of the surface expression of seeps from space images indicate numerous other communities may exist (MacDonald et al., 1993 and 1996). Most chemosynthetic communities are of low density and are relatively widespread throughout the deepwater areas of the Gulf. Physical disturbance or destruction of a small, low-density area would not result in a major impact to chemosynthetic communities as an ecosystem. Low-density communities may occasionally sustain impacts from discharges of drill muds and cuttings, bottom-disturbing activities, or resuspended sediments. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans). In light of probable avoidance of all chemosynthetic communities (not just high-diversity types) as required by NTL 2000-G20, the frequency of such impact is expected to be very low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos. Recolonization after a disturbance would not exactly reproduce the preexisting community prior to the impact, but it could be expected that some similar pattern and species composition would eventually reestablish if similar conditions of sulfide or methane seepage persist after the disturbance.

Summary and Conclusion

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment in the same locations.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience very minor (if any) impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

4.2.2.1.4.2.2. Nonchemosynthetic Deepwater Benthic Communities

Benthic communities other than chemosynthetic organisms could be impacted by OCS-related bottom-disturbing activities associated with pipelaying (**Chapter 4.1.1.3.8.1**), anchoring (**Chapter 4.1.1.3.3.1**), and structure emplacement (**Chapter 4.1.1.3.3**), as well as from a seafloor blowout (**Chapter 4.3.2**). Potential impacts from blowouts are discussed in **Chapter 4.4.4.2.2**. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage can be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. These impacts are the same as those encountered in shallower continental shelf waters.

Anchors from support boats and ships (or from any buoys set out to moor vessels), floating drilling units, pipelaying vessels, and pipeline repair vessels also cause severe disturbances to small areas of the seafloor with the areal extent related to the size of the mooring anchor and length of chain that would rest on the bottom. Excessive scope (length) and movement of the mooring chain could disturb a much larger area of the bottom than would an anchor alone, depending on the prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could impact communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the floating central drilling structure. Larger anchors and additional scope of anchor chain are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. The use of other anchoring technologies such as suction pile anchors would reduce the impacted area. The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. (Many OCS-support operations and activities will not result in anchor impacts to deepwater benthic communities because vessels will tie-up directly to rigs, platforms, or mooring buoys or will use dynamic positioning). Anchoring will not necessarily directly destroy small infaunal organisms living within the sediment; the bottom disturbance would most likely change the environment to such an extent that the majority of the directly impacted infauna community would not survive (e.g., burial or relocation to sediment layers without sufficient oxygen). In cases of carbonate outcrops or reefs with attached epifauna or coral, the impacted area of disturbance may be small in absolute terms, but it could be large in relation to the area inhabited by fragile hard corals or other organisms that rely on exposed hard substrate.

As described in the previous section for chemosynthetic communities, normal pipelaying activities in deepwater areas could destroy large areas of benthic communities (it is assumed that 0.32 ha (0.79 ac) of bottom is disturbed per kilometer of pipeline installed.); although, without consideration of chemosynthetic organisms, there are no differences between this activity in deep water as compared to shallow-water operations below 200 ft where pipeline burial is not required.

In addition to direct physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below.

Discharges

In deep water, discharges of drilling muds and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. As detailed in the previous section (**Chapter 4.2.2.1.4.2.1**), some information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m of water has been reported by Gallaway and Beaubien (1997), as well as a major new study looking at both exploratory and production drilling in water depths of 1,000 m (3,281 ft) (CSA, 2006). The latter study found drilling mud accumulations ranging up to several hundred meters away from wells in thickness ranging from 2 to 4 cm (1 to 2 in).

Impact from muds and cuttings are also expected from two additional sources: (1) initial well drilling prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various riserless drilling techniques in the deep sea. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Company, 1995). In the case of some riserless drilling practices, all muds and cuttings from well spudding through total depth would be discharged at the seafloor. Although the full areal extent and depth of burial from these activities is not known, the potential impacts are expected to be localized and short term. Since these areas would occupy only a minuscule portion of the available seafloor in the deepwater GOM, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

Burial by sediments or rock fragments originating from drilling muds and cuttings discharges could smother and kill almost all community components of benthic organisms, with the exception of highly motile fish and possibly some crustaceans such as shrimp capable of moving away from the impacted area. Depending on the organism type, just a few centimeters of burial could cause death. The damage would be both mechanical and toxicological. Some types of macrofauna could burrow through gradual accumulations of overlying sediments depending on the toxicological effects of those added materials. Information on the potential toxic effects on various benthic organisms is limited and essentially nonexistent for deepwater taxa.

It can be expected that detrimental effects due to burial would decrease exponentially with distance from the origin. The physical properties of the naturally occurring surface sediment (grain size, porosity, and pore water) could also be changed as a result of discharges such that recolonizing benthic organisms would be comprised of different species than inhabited the area previous to the impact. Although the impacts could be considered severe to the nonmotile benthos in the immediate area affected, they would be considered very temporary. Due to the proximity of undisturbed bottom with similar populations of benthic organisms ranging in size from microbenthos to megafauna, these impacts would be very localized and reversible at the population level and are not considered significant.

Carbonate outcrops and deepwater coral communities not associated with chemosynthetic communities, such as the deepwater coral "reef" or habitat first reported by Moore and Bullis (1960) and later by Schroeder (2002), are considered to be most at risk from oil and gas operations. Due to the fact that deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover. However, the principal habitat-forming coral taxa, *Lophelia*, at the best developed site in Viosca Knoll Block 826 does form structures with some relief that would be more resistant to any conceivable thickness of drill cuttings. Burial of previously exposed hard substrate would prevent future recolonization until some event that excavated the substrate again.

Effluents other than muds or cuttings from routine OCS operations in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m (328 ft).

Proposed Action Analysis

For a proposed action in the CPA, 5-12 oil and gas structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2007 and 2046 in offshore subareas C400-800, C800-1600, C1600-2400, and C>2400 (**Table 4-3, Figure 4-1**). These deepwater production structures are expected to be installed beginning in the third year and continue throughout the analysis period. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Surface discharge of muds and cuttings, as opposed to seafloor discharge, would reduce or eliminate the impact of smothering the benthic communities on the bottom.

Under the current review procedures for chemosynthetic communities, carbonate outcrops are targeted as one possible indication (surface anomaly on 3D seismic survey data) that chemosynthetic seep communities could be nearby. Unique communities that may be associated with any carbonate outcrops or other topographical features could be identified via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a geological hazard for any well sites. Any proposed activity in water depth greater than 400 m (1,312 ft) would automatically trigger the NTL 2000-G20 evaluation described above.

Summary and Conclusion

Some impact to soft-bottom benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic infaunal communities occurred, recolonization from populations from neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be relatively rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities. Impacts to other hard-bottom communities are expected to be avoided as a consequence of the application of the existing NTL 2000-G20 for chemosynthetic communities. The same geophysical conditions associated with the potential presence of chemosynthetic communities also results in hard carbonate substrate that is generally avoided.

4.2.2.1.5. Impacts on Marine Mammals

Potential effects on marine mammal species may occur from routine OCS activities and may be direct or indirect. The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and marine debris from service vessels and OCS structures.

Discharges

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced sand and well treatment, workover, and completion fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater. The USEPA, through general permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities.

Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (Neff et al., 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Trace metals, including mercury, in drilling discharges have been a particular concern. However, Neff et al. (1989) concluded that metals associated with drilling fluid were virtually nonbioavailable to marine organisms. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from stranded GOM bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (Neff et al., 1989). Adequate baseline data are not available to determine the significant sources of contaminants that accumulate in Gulf cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the GOM from a variety of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. Coastal cetacean species tend to have higher levels of metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al,. 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft between platforms.

Marine mammals often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as species, the activity the animals are engaged in, and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters or those with calves sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occur. Absence of conspicuous responses to an aircraft does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitations, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladed vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). Noise could disturb marine mammals in the immediate vicinity of a service vessel; however, this effect would be limited in area and duration.

Worldwide records of vessel collisions with sperm whales are fairly common (Laist et al, 2001). Records of vessel collisions with Bryde's whales (considered rare in the GOM; the only regularly occurring baleen whale in the GOM) are rare. Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales and that (1) the majority of collisions appear to occur over or near the continental shelf, (2) most lethal or severe injuries are caused by ships 80 m or longer, (3) whales usually are not seen beforehand or are seen too late to be avoided, and (4) most lethal or severe injuries involve ships traveling 14 kn or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001).

Increased traffic from support vessels involved in survey, service, or shuttle functions will increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared with control periods (no boats present within 100 m (328 ft)) in a study conducted in Sarasota Bay, Florida. They also found that dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or growth, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the leased sites could affect them. Fertl et al. (2005) found manatees to be most common in estuarine and river mouth habitats and rare in the open ocean. A manatee present where there is vessel traffic could be injured or killed by a vessel strike (Wright et al., 1995). In 1995, an oil crew workboat struck and killed a manatee in a canal near coastal Louisiana (Fertl et al., 2005). Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to detect effectively boat noise and avoid collisions with boats (Gerstein et al., 1999).

Drilling and Production Noise

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Toothed whales use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994). This throws doubt on the assumed insensitivity of toothed whale hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many industrial sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). As many OCS-industry sounds are concentrated at low frequencies, there is particular concern for baleen whales as they are apparently more dependent on low-frequency sounds than are other marine mammals. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. The response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but marine mammals may be affected by noise in difficult-to-observe ways. For example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause behavioral changes that affect feed intake, social interactions, or parenting. All of these effects might eventually result in population declines (Bowles, 1995).

Structure Removals

A limited amount of information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998). The shock wave produced by explosions can cause physical damage to nearby animals. The potential for injury is associated with gas-containing internal organs, such as the lungs and intestines (Yelverton et al., 1973). Data are limited regarding blast-induced auditory damage. Explosions and shock waves and their intense transient sound field have the ability to produce blast injury and acoustic trauma in marine mammals (Ketten, 1995 and 1998). Consequences of hearing damage may range from subtle modification of certain behaviors to acute, where concussive effects may lead to death (Ketten, 1995).

For example, two humpback whales were found with damage to their ear bones following an explosion in Newfoundland (Ketten et al., 1993). Yet other humpback whales in Newfoundland, foraging in an area of explosive activity, showed little behavioral reaction to the detonations in terms of decreased residency, overall movements, or general behavior, although orientation ability appeared to be affected (Todd et al., 1996). Todd et al. (1996) suggested caution in interpretation of the lack of visible reactions as indication that whales are not affected or harmed by an intense acoustic stimulus; both long- and short-term behavior as well as anatomical evidence should be examined. The researchers interpreted increased entrapment rate of humpback whales in nets as the whales being influenced by the long-term effects of exposure to deleterious levels of sound.

Toothed whales cannot hear well in the frequencies emitted by explosive detonations (Richardson et al., 1995). The animals may not be able to hear the pulse generated from open-water detonations of explosive charges because it is very brief (*Federal Register*, 1995b). Sublethal effects would include a startle response. Even if dolphins are not capable of hearing the acoustic signature of the explosion, physiological, pathological, or behavioral responses to detonations may still result. The NOAA Fisheries Service (USDOC, NMFS, 1995) cites such examples as detection of low-frequency sound by some mechanism other than conventional hearing and harassment because of tactile stings from the shock wave accompanying detonations. Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995b). Because of its temporary effect, no impacts to higher life forms are expected, and, because of its temporary and localized nature, biomagnification is unlikely.

The extent of potential injury is dependent upon the amount of explosive used, distance from the charge, and body mass of the cetacean. There is no evidence linking dolphin injuries or deaths in the GOM to explosive removal of structures (Klima et al., 1988; Gitschlag et al., 1997). In October 1995, NOAA Fisheries Service issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of gas drilling and production structures in State waters and on the GOM OCS for a period of five years (*Federal Register*, 1995b). The NOAA Fisheries Service is currently in the final stages of completing rulemaking under the MMPA, and the associated ESA consultation, for explosive removal of structures in the GOM.

In order to minimize the likelihood of injury to marine mammals from explosive structure removals, MMS has issued guidelines (NTL 2004-G06) to offshore operators. These guidelines specify (1) explosive removals only during daylight hours, (2) staggered detonation of explosive charges, (3) placement of charges 5 m (15 ft) below the seafloor, and (4) pre- and post-detonation aerial surveys within 1 hour before and after detonation. Trained observers watch for sea turtles and marine mammals in the vicinity of the structures to be removed.

Seismic Surveys

The MMS completed a programmatic EA on G&G permit activities in the GOM (USDOI, MMS, 2004) and is currently in consultation with NOAA Fisheries Service for rulemaking under the MMPA and the associated ESA procedure. The PEA includes a detailed description of the seismic surveying technologies, energy output, and operations. This document is hereby incorporated by reference. Seismic surveys use a high-energy noise source. During Irish Sea seismic surveys, pulses were audible on hydrophone recordings above the highly elevated background ship noise at least up to the 20-km (12-mi) range (Goold and Fish, 1998). Although the output of airgun arrays is usually tuned to concentrate low-frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish, 1998). These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and extend well into the ultrasonic range up to 50 kHz.

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km (4-5 mi) of an airgun array. Humpback whales off western Australia were found to change course at 3-6 km (2-4 mi) from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (2 mi) (McCauley et al., 1998a and b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km (4-7 mi) from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). For baleen whales, in particular, it is not known whether (1) the same individuals return to areas of previous seismic exposure, (2) seismic work has caused local changes in distribution or migration routes, or (3) whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). Individually identified gray whales remained in Puget Sound long after the seismic survey (as is typical), despite being exposed to noise (Calambokidis and Osmek, 1998; Bain et al., 1999).

Goold (1996) found that acoustic contacts with common dolphins in the Irish Sea dropped sharply as soon as seismic activity began, suggesting a localized disturbance of dolphins. Given the high, broadband seismic-pulse power levels across the entire recorded bandwidth and the known auditory thresholds for several dolphin species, Goold and Fish (1998) considered such seismic emissions to be clearly audible to dolphins across a bandwidth of tens of kilohertz and at least out to the 8-km (5-mi) range. No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out during a 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observable behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996).

Results of passive acoustic surveys to monitor sperm whale vocal behavior and distribution in relation to seismic surveys in the northeast Atlantic revealed few, if any, effects of airgun noise (Swift et al., 1999). The authors suggested that sperm whales in that area may be habituated to seismic surveys and/or responses may occur at scales to which the research was not sensitive. Sperm whales during the Heard Island Feasibility Test were found to cease calling during some (but not all) times when seismic pulses were received from an airgun array >300 km (186 mi) away (Bowles et al., 1994). In contrast, sperm whales in the Gulf were frequently heard vocalizing while seismic pulses were ongoing. It is unclear whether the well-documented, continued occurrence of sperm whales in the area off the mouth of the Mississippi River is a consequence of low sensitivity to seismic sound or a high motivation to remain in the area. Sperm whales have historically occupied this area and their continued presence might suggest habituation to the seismic signals. During the MMS-sponsored GulfCet II study on marine mammals, results showed that the cetacean sighting rate did not change significantly because of seismic exploration signals (Davis et al., 2000). The analysis of the results was unable to detect small-scale (<100 km, <62 mi) changes in cetacean distribution.

Since the last multisale EIS, MMS conducted annual research cruises under the Sperm Whale Seismic Study (SWSS) program through 2005. The final year, 2006, is being devoted to data analysis and the publication of a synthesis report, including the various facets of SWSS. A detailed report of the research conducted from 2002 through 2004 has been published (Jochens et al., 2005). Experiments were designed to investigate the sound exposure level at which behavioral changes began to occur. The primary tool for this investigation was the D-tag used in conjunction with seismic airgun controlled exposure experiments (CEE's) to quantify changes in the behavior of sperm whales throughout their dive cycle. Eight whales were tagged over two field seasons (2002-2003). The acoustic exposure and foraging behavior of these whales were recorded on the D-tag before, during, and after a 1- to 2-hr controlled sound exposure to typical airgun arrays. The maximum sound level exposures for the eight whales were between 130 and at least 162 dBp-p re 1 μPa at ranges of 1.5-12.8 km (0.9-8.0 mi) from the sound source.

The whales showed no change to diving behavior or direction of movement during the gradual ramp-up or during the full-power sound exposures. There was no avoidance behavior toward the sound source. Foraging behavior was temporarily altered for the whale that was approached most closely. The surface resting period was prolonged hours longer than typical, but normal foraging behavior resumed immediately after the airguns ceased. The increased surface period may be a type of vertical avoidance to the sound source as the received sound level at the surface is expected to be less than farther down in the water column. There was a decrease of "buzzes" (distinctive echolocation sounds thought to be produced by sperm whales during prey capture attempts) in the foraging dives of the other exposed whales when compared with those of unexposed whales; however, the decrease was not statistically significant. Other analyses applied to these results led the researchers to suggest that a 20 percent decrease in foraging attempts at exposure levels ranging from <130 to 162 dBp-p re 1 μPa at distances of roughly 1-12 km (0.6-8 mi) from the sound source is more likely than no effect.

Whale locations from S-tags were compared with positions of active seismic vessels to determine whether tagged whales occurred less frequently than expected in areas of active seismic surveys in the GOM (potential vessel avoidance behavior). Chi-square testing and Monte Carlo simulations revealed no evidence that the data (whale locations) were nonrandomly distributed. However, the researchers caution that this apparent lack of avoidance to the seismic vessels is based on a very small sample size and cannot be used to refute a possible behavioral response. The sperm whale sightings of the visual team aboard the *Gyre* were also analyzed to investigate medium-term responses of whales to seismic surveys occurring in the area. No significant responses were observed in (1) the heading relative to the bearing to seismic surveys, (2) time spent at the surface, or (3) surfacing rate in the comparisons of matched pairs 2 hr before and 2 hr after line starts and line ends for survey lines within 100, 50, or 25 mi.

The results of these three independent approaches suggest that sperm whales display no horizontal avoidance to seismic surveys in the GOM. However, these observations are based on very few exposures <160 dBp-p re 1 μPa. Also, these experiments were carried out in an area with substantial human activity and the whales are not naive to human-generated sounds.

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given the transitory nature of seismic exploration, the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals, and the avoidance responses that occur in at least some baleen whales, when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Marine Debris

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and the Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and ingestion of, or entanglement in, discarded material could injure or kill cetaceans.

Proposed Action Analysis

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and human-generated debris from service vessels and OCS structures.

Some industry-generated effluents are routinely discharged into offshore marine waters. Marine mammals may have some interaction with these discharges. Indirect effects to marine mammals through prey exposure to discharges are expected to be sublethal. Because OCS discharges are diluted and dispersed in the offshore environment, direct impacts to marine mammals are expected to be negligible.

Helicopter operations (take-offs and landings) projected for a proposed action in the CPA are 1,000,000-2,200,000 operations (**Table 4-3**) over the life of a proposed action. This equates to an average annual rate of 25,000-55,000 operations. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. In addition, guidelines and regulations issued by NOAA Fisheries Service under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that marine mammals would be affected by routine OCS helicopter traffic operating at these altitudes. It is expected that about 10 percent of helicopter operations would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from and interrupt marine mammals nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on marine mammals; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding. Temporary disturbance to marine mammals may occur as helicopters approach or depart OCS facilities if animals are near the facility. Such disturbance is believed negligible.

Service-vessel round trips projected for a proposed action in the CPA are 117,000-239,000 trips (**Table 4-3**) over the life of a proposed action. This equates to an average annual rate of 2,925-5,975 trips. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from marine mammals or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. Bejder et al. (2005) found that bottlenose dolphins per km^2 significantly declined with increasing tour operators. These were long-term impacts that had not been noticed when earlier studies had emphasized short-term behavioral responses. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Dolphins may approach vessels that are in transit to bow-ride. Manatees are known to have been killed by vessel strikes (e.g., Schiro et al., 1998) and most manatees bear prop scars from contact with vessels. However, manatees are rare in the Western and Central Gulf and consequently, OCS vessel traffic should pose little risk to that endangered species. The rapid increase in exploration and development of petroleum resources in deep oceanic waters of the northern Gulf has increased the risk of OCS vessel collisions with sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales may be more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. MMS has issued regulations and guidelines to minimize the chance of vessel strike to marine mammals with proposed protected species lease stipulations and NTL 2003-G10, “Vessel Strike Avoidance and Injured/Dead Protected Species Reporting.”

A total of 65-96 exploration and delineation wells and 330-468 development wells are projected to be drilled as a result of a proposed action in the CPA. A total of 28-39 platforms are projected to be installed as a result of a proposed action. These wells and platforms could produce sounds at intensities and frequencies that could be heard by marine mammals. It is expected that noise from drilling activities would be relatively constant during the temporary duration of drilling. Toothed whales echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms (Gales, 1982). Bottlenose dolphins, one of the few species in which low-frequency sound detection ability has been studied, have poor sensitivity at the level where most OCS-industry noise energy is concentrated. Baleen whales are apparently more dependent on low-frequency sounds than other marine mammals and may be species of concern regarding OCS-industry noise. However, all baleen whale species except the Bryde's whale are considered extralimital or accidental in the GOM. Bryde's whales are considered rare in the Gulf and observations of this species have been almost exclusively in the Eastern GOM (Davis et al., 2000). Thus, Bryde's whales and other baleen whale species are not likely to be subjected to OCS drilling and production noise. Potential effects on GOM marine mammals include disturbance (i.e., subtle changes in behavior, interruption of previous activities, or short- or long-term displacement), masking of natural sounds (e.g., surf, predators) and calls from nonspecifics, stress (physiological), and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/ or auditory system could occur. Harassment of marine mammals as a result of a noninjurous physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. It is estimated that 14-16 production structures resulting from a proposed action will be removed using explosives. It is expected that structure removals will cause only minor behavioral changes and noninjurious physiological effects on marine mammals as a result of the implementation of MMS NTL guidelines and regulations, and the NOAA Fisheries Service Observer Program for explosive removals. To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures.

Many types of materials, including plastics, are used during drilling and production operations. Some of this material is accidentally lost overboard where marine mammals could consume it or become entangled in it. The result of ingesting some materials lost overboard could cause disease or death. Entanglement is a concern as some packaging materials may be of a size and/or shape that could be impossible for a marine mammals to jettison. Many of the plastics used by industry could withstand years of saltwater exposure without disintegrating or dissolving. An entangled marine mammal may suffer from acute impaired mobility that compromises its health quickly, or it may decline slowly from diminishing feeding and reproductive capability. The increased energy required to overcome the handicap of entanglement may require more food than the entangled whale can capture. Industry directives for reducing marine debris and MMS's guidelines through its NTL for maintaining awareness of the problem and eliminating accidental loss continue to minimize industry-related trash in the marine environment.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by a chance collision with a service vessel; however, current MMS requirements and guidelines for vessel operation in the vicinity of protected species should minimize this risk (the proposed Protected Species Lease Stipulation and NTL 2003-G10).

Marine mammal ingestion of industry-generated debris, which is accidentally released, is a concern. Sperm whales may be particularly at risk because of their suspected feeding behavior involving cruising along the bottom with their mouth open. Entanglement in debris could have serious consequences. A sperm whale could suffer diminished feeding and reproductive success, and potential injury, infection and death from entanglement in discarded packing materials or debris. Industry has made good progress in debris management on vessels and offshore structures in the last several years. The debris awareness training, instruction, and placards required by the proposed Protected Species Lease Stipulation and NTL 2003-G11 should greatly minimize the amount of debris that is accidentally lost overboard by offshore personnel.

There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Noise associated with a proposed action, including drilling noise, aircraft, and vessels may affect marine mammals by eliciting a startle response or masking other sounds. However, many of the industry-related sounds are believed to be out of, or on the limits of, marine mammal hearing, and the sounds are also generally temporary. The continued presence of sperm whales in close proximity to some of the deepwater structures in the GOM tends to rule out concerns of permanent displacement from disturbance.

Seismic operations have the potential to harm marine mammals in close proximity to firing airgun arrays. The proposed protected species lease stipulations and the several mitigations, including onboard observers and airgun shut-downs for whales in the exclusion zone, included in NTL 2004-G01 ("Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program") minimize the potential of harm from seismic operations to marine mammals.

Marine mammal death or injury is not expected from explosive structure removal operations. Existing mitigations and those recently developed for structures placed in oceanic waters should continue to minimize adverse effects to marine mammals from these activities.

Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification. Although the scope and magnitude of such effects are not known, direct or indirect effects are not expected to be lethal.

Routine activities related to a proposed action, particularly when mitigated as required by MMS, are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population endemic to the northern GOM.

4.2.2.1.6. Impacts on Sea Turtles

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational contaminant discharges; noise from seismic exploration, helicopter and vessel traffic, operating platforms, and drillships; vessel collisions; explosive platform removals; and OCS-related trash and debris.

Contaminants and Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by USEPA NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web. Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling mud. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the GOM carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights; however, anecdotal reports indicate that sea turtles often react to the sound and/or the shadow of an aircraft by diving. It is assumed that aircraft noise can be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided because of noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sound responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been observed noticeably increasing their swimming in response to an operating seismic source at 166 dB re-1µPa-m (McCauley et al., 2000). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). Increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel strikes are a cause of sea turtle mortality in the Gulf (Lutcavage et al., 1997). Stranding data for the U.S. Gulf and Atlantic Coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997). Vessel-related injuries were noted in 13 percent of stranded turtles examined from the GOM and the Atlantic during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5-50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles will be impacted.

Explosive Platform Removals

Offshore structures serve as artificial reefs and are sometimes used by sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, green, Kemp's ridley, and hawksbill have also been observed (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). Loggerheads may reside at specific offshore structures for extended periods of time (Rosman et al., 1987b; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987b). Sea turtles probably use platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been observed sleeping under platforms or beside support structures (Hastings et al., 1976; Rosman et al., 1987b; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989 and 1990).

Information about the effects of underwater explosions on sea turtles is limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and suggested that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NOAA Fisheries Service conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, turtles within 3,000 ft of the platform were rendered unconscious (Klima et al., 1988), although they resumed apparently normal activity 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage to the cloacal lining (it was everted) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for three weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed 1 hr. Injured turtles that are capable of swimming may return to the surface, while moribund turtles may sink to the seafloor or drift away from the work site. Unconsciousness renders a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives is two loggerheads during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one loggerhead in 1997 (Gitschlag, personal communication, 1999), one loggerhead in 1998 (Shah, personal communication, 1998), and one loggerhead in 2001 (Gitschlag, personal communication, 2001). A total of six additional sea turtles have been captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). The low number of turtles affected by explosive removal of structures may be because of the few turtles that occur in harm's way at the time explosives are detonated, the effectiveness of the monitoring program established to protect sea turtles, and/ or the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), NMFS initiated an observer program at explosive removals of structures in State and Federal waters of the GOM. For at least 48 hours prior to detonation, NMFS observers watch for sea turtles at the surface. Helicopter surveys within a 1-mi radius of the removal site are conducted a minimum of 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath structures.

Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments because of explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995b). Because of its temporary effect and localized nature, biomagnification is unlikely.

The MMS petitioned NMFS for MMPA rulemaking for explosive removal activities in 2004. At present (mid-2006), NMFS has published the proposed rule. The accompanying ESA consultation and Biological Opinion are close to being final. In preparation for rulemaking, MMS held a mitigation workshop in 2005 to establish suggested explosive removal mitigations that would satisfy NMFS and that would be feasible for industry.

Marine Debris

A wide variety of trash and debris is commonly observed in the Gulf. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, 40,580 debris items were collected in a 16-mi transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1997). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1997). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open ocean voyage. Some hatchlings spend their "lost years" in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The GOM had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp's ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Effluents are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Information on the contaminants that would be discharged offshore as a result of a proposed action is provided in **Chapter 4.1.1.4**. Turtles may be affected by these discharges. Very little information exists on the impact of drilling muds on Gulf sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in **Chapters 4.2.2.1.3.3 and 4.2.2.1.4.1.1**. The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a proposed action because these sensitive resources are protected by several mitigation measures established by MMS. These mitigation measures include marine protected species NTL's (**Chapter 1.5**).

An estimated 2,925-5,975 service-vessel round trips are expected to occur annually as a result of a proposed action. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter operations are expected to be 25,000-55,000 (take-offs and landings) per year as a result of a proposed action. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles and there is the possibility of short-term disruption of activity patterns. In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

A total of 65-96 exploration wells and 330-468 producing development wells are projected to be drilled as a result of a proposed action. A total of 28-39 platforms are projected to be installed as a result of a proposed action. Of those 14-16 are projected to be removed with explosives. These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of activity), masking of other sounds (e.g., surf, predators, vessels), and stress (physiological).

Sea turtles can become entangled in or ingest debris produced by exploration and production activities resulting from a proposed action. Leatherback turtles that mistake plastics for jellyfish may be more vulnerable to gastrointestinal blockage than other sea turtle species. The probability of plastic ingestion/entanglement is unknown.

Summary and Conclusion

Routine activities resulting from a proposed action have the potential to harm sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by seismic exploration, helicopter and vessel traffic, platforms, and drillships; vessel collisions; and marine debris generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. Most OCS activities are expected to have sublethal effects.

Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification but there is uncertainty concerning the possible effects. Rapid dilution of the discharges should minimize impact. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas from noise disturbance could cause declines in survival or fecundity, and result in population declines; however, such declines are not expected. The required seismic operation mitigations, particularly clearance of the impact area of sea turtles and marine mammals prior to ramp-up, and the subsequent gradual ramping up of the airguns, should minimize the impact of rapid onset of, and close proximity to, very loud noise. Vessel traffic is a serious threat to sea turtles. Diligence on the part of vessel operators as encouraged by the vessel strike mitigations should minimize vessel/sea turtle collisions. Actual sea turtle impacts from explosive removals in recent years have been small. The updated pre- and post-detonation mitigations should insure that injuries remain extremely rare. Greatly improved handling of waste and trash by industry, along with the annual awareness training required by the marine debris mitigations, is decreasing the plastics in the ocean and minimizing the devastating effects on sea turtles. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the GOM.

4.2.2.1.7. Impacts on Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

The Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice are designated as protected species under the Endangered Species Act of 1973 (**Chapter 1.3**, Regulatory Framework). The mice occupy restricted habitat behind coastal foredunes of Florida and Alabama (Ehrhart, 1978; USDOI, FWS, 1987). Portions of the beach mouse habitat have been designated as critical.

Proposed Action Analysis

The major impact-producing factors associated with a proposed action that may affect beach mice include beach trash and debris, efforts undertaken for the removal of marine debris or for beach restoration, offshore and coastal oil spills, and spill-response activities. The potential impacts from spills and spill-response on beach mice activities are discussed in **Chapter 4.3.5**.

Beach mice may mistakenly consume trash and debris. Mice may become entangled in the debris. A proposed action is expected to contribute negligible marine debris or disruption to beach mice areas. Efforts undertaken for the removal of marine debris, may temporarily scare away beach mice, destroy their food resources such as sea oats, or collapse the tops of their burrows.

Summary and Conclusion

An impact from a proposed action on the Alabama, Choctawhatchee, St. Andrew and Perdido Key beach mice is possible but unlikely. Impact may result from consumption of beach trash and debris. A proposed action would deposit only a small portion of the total debris that would reach the habitat.

Efforts undertaken for the removal of marine debris, may temporarily scare away beach mice, destroy their food resources, or collapse the tops of their burrows.

4.2.2.1.8. Impacts on Coastal and Marine Birds

This section discusses the possible effects of a proposed action in the CPA on coastal and marine birds of the GOM and its contiguous waters and wetlands. Major, potential impact-producing factors for marine birds in the offshore environment include OCS-related helicopter and service-vessel traffic and noise, air emissions, degradation of water quality, habitat degradation, discarded trash and debris from service-vessels and OCS structures, and structure lighting and presence. Any effects on birds are especially grave for intensively managed populations. For example, endangered and threatened species may be harmed by any impact on viable reproductive population size or disturbance of a few key habitat factors.

Proposed Action Analysis

Noise

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, and boats and a variety of service vessels. It is projected that 1,000,000-2,200,000 helicopter operations related to a proposed action in the CPA would occur over the life of a proposed action; this is a rate of 25,000-55,000 annual helicopter operations. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. It is projected that 117,000-239,000 service-vessel round trips related to a proposed action in the CPA would occur in the life of a proposed action; this is a rate of 2,925-5,975 service-vessels trips annually.

Disturbances from OCS-related helicopter or service-vessel traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior. Disturbance can also lead to a permanent desertion of active nests and even whole nest colonies, or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure resulting from nest abandonment. Interruption of nesting activities such as nest building (sensitive to time budgets), foraging for food for nestlings (sensitive to time and energy budgets), and incubation of eggs and naked nestlings (sensitive to time budgets) may result in reduced breeding success, measured by the ratio of birds fledged per nest to eggs hatched from a clutch. Impacts on whole nesting colonies of seabirds would be especially serious. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not reach their destination on schedule or they may be more susceptible to diseases (Anderson, 1995).

Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because aerial predators frequently harass them (Bowles, 1995). The FAA and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds.

The effect of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. However, pilots traditionally have taken great pride in not disturbing birds. Compliance to the specified minimum altitude requirements greatly reduces effects of aircraft disturbance on coastal and marine birds. Routine presence of aircraft at sufficiently high altitudes results in acclamation of birds to routine noise. As a result of inclement weather, about 10 percent of helicopter operations would occur at altitudes somewhat below the minimums listed above. Although these incidents are seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment. Birds in flight over water typically avoid helicopters. Low-flying aircraft may temporarily disrupt feeding or flight paths, including low-altitude foraging trips where birds scan the ground for small prey or scan the water for schools of small pelagic fish. Routine presence and low speeds of service vessels within inland and coastal waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Birds can lose eggs and young when predators attack nests after parents are flushed into flight by service-vessel noise. Overall breeding success (ratio of fledged birds per nest to hatched birds per nest) may be reduced. Chronic effects on breeding are especially serious for endangered or threatened species because subsequent recovery may not occur.

Air Quality Degradation

Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemic condition, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). Pollutants will accumulate in tissues with unusually low temperatures, low blood content, and low blood flow. Fatty tissues in any organism are especially serious sinks for nonpolar, non-ionic, hydrophobic pollutants. Such pollutants are probably transmitted up the food web without amplification or diminution in concentration. The total amounts transferred up the web probably relate to the total fat content of the components of the food web. Seabirds usually feed in flight and need only resupply moderate protein and fat stores. However, songbirds and shorebirds cannot feed over barriers like the open water of the GOM and need to store up large amounts of fat before flight over them. Such fat stores are especially sensitive to accumulation of hydrophobic contaminants. Top predators on trans-Gulf migrants, such as the breeding peregrine falcons on offshore platforms, are somewhat sensitive to accumulation of such contaminants, but the toxins are no threat compared with the historical notorious effects of polychlorinated insecticides on egg-shell thinning in top bird predators such as the bald eagle and peregrine falcon. For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981). Migratory birds may be sensitive because of sustained high ventilation rates required for flight.

Levels of sulfur oxide (mainly sulfur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities are of concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken and results from these studies are not necessarily applicable to wild bird species. Acute exposure of birds to 100 ppm SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH.

Exposure to 100 ppm or less of SO_2 did not affect respiratory mucous secretion. Exposure to 1,000 ppm SO_2 caused mucus to increase and drip from the mouths of birds, but lungs appeared normal. Exposure to 5,000 ppm resulted in gross pathological changes in airways and lungs, and then death (Fedde and Kuhlmann, 1979). Chronic (two week) exposure of birds to three concentrations of SO_2 for 16 hr/day for various total periods showed a statistical change in 10 cellular characteristics and resulted in cellular changes characteristic of persistent bronchitis in 69 percent of the tests done (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980). Accumulation of toxic compounds from such emissions are more probable in birds feeding on terrestrial or aerial prey that breathe air and accumulate contaminants in air of poor quality.

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species will avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties, are also greatly affected by natural factors such as weather and food supply. Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

Chapter 4.2.1.4 provides an analysis of the effects of a proposed action in the CPA on air quality. Emissions of pollutants into the atmosphere from the activities associated with a proposed action would have minimum effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates, and pollutant concentrations. Estimated increases in onshore annual average concentrations of NO_2, SO_2, and PM_{10} would be less than 0.42, 0.04, and 0.02 micrograms/m^3, respectively, per modeled steady state concentrations. These concentrations are far below concentrations that could harm coastal and marine birds.

Water Quality Degradation

Chapter 4.2.1.3 provides an analysis of the effects of a proposed action in the CPA on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Operational discharges or runoff in the offshore environment could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms. These impacts could also be both direct and indirect. Many seabirds feed and nest in the Gulf, so water quality may affect breeding success also (measured as the ratio of fledged birds per nest to hatched birds per nest).

Maintenance dredging operations remove several million cubic feet of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations. Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. A proposed action would result in very small incremental contribution to the need for channel maintenance. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, sublethal physiological stress. Some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Habitat Degradation

Habitat can be described as the physical environment and as the plant substrates used by a bird. The northern GOM and areas inland from it have a large diversity of habitats for birds of all types, including migrants, wintering birds, and breeding birds. The greatest negative impact to coastal and marine birds is loss or degradation of preferred or critical habitat. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Habitat requirements for most bird species are incompletely known. Bird species with similar habitat may crowd each other, depending on amounts of available habitat controlling bird population sizes versus other types of population regulation.

Generally, destruction of wetland habitat from OCS pipeline landfalls and onshore construction may displace localized groups or populations of birds. Environmental regulations require replanting and restoration of wetlands destroyed by pipelaying barges and associated onshore pipeline installation. As these birds move to undisturbed areas of similar habitat, their presence may augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space or food. Pipeline landfalls and terminals, and other onshore OCS-related construction, can destroy coastal bird feeding or nesting habitat and can displace coastal bird populations from affected areas. Seabird nesting colonies are especially sensitive and should always be avoided by construction activities. Onshore pipelines cross a wide variety of coastal environments, including freshwater marsh and canals, and can therefore affect certain species generally not associated with marine or estuarine systems. These include certain waders, marsh birds, shorebirds, and waterfowl. For a proposed action in the CPA, 0-1 new pipeline landfalls (**Chapter 4.1.2.1.7**) and 0-1 new gas processing plants (**Chapter 4.1.2.1.4.2**) are projected.

The analysis of the potential impacts to coastal environments (**Chapter 4.2.1.1**) concludes that a proposed action in the CPA is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. Grand Isle is the only inhabited beach area on the Louisiana coast, but many unoccupied beaches occur. Initial adverse impacts and more secondary impacts of pipeline and navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands. Initial impacts are locally significant and largely limited to where OCS-related canals and channels pass through wetlands. Secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found.

Debris

Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that 80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxon (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals including lethal and chronically damaging substances (Ryan, 1990; Sileo et al., 1990a). Effects of plastic ingestion may last a lifetime and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could reduce survival rates and breeding success. Accumulation of plastic debris near foraging areas for seabird nesting colonies would be devastating to a whole cohort of fledging birds, especially industrial substances not intended to be associated with food consumption and other human activities where a health hazard would result. The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of ingested plastic found within the gut of examined birds varied greatly among species. Species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the GOM, these include the phalaropes, petrels, storm petrels, and shearwaters. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters, went into effect January 1, 1989, and is enforced by the USCG.

Structures

Every spring, migratory land birds, including neotropical passerines that cannot feed at the water surface or rest there, cross the GOM from wintering grounds in Latin America to breeding grounds north of the GOM. Some birds use offshore platforms as stopover sites for this migration that may enhance fitness.

Migrants sometimes arrive at certain platforms shortly after nightfall and proceed to circle those platforms (the phenomenon is called a nocturnal circulation event) for variable periods ranging from minutes to hours. Russell (2005) notes that "because of the anecdotal nature of our circulation observations, we are reluctant even to speculate about the average duration of participation in circulation or the typical energetic consequences of participating in these events." The number of birds participating in these circulations at one time at one platform was measured at 1,260 individuals. It is projected that 28-39 platforms are projected to be installed as a result of a proposed action in the CPA.

Summary and Conclusion

The majority of effects resulting from a proposed action in the CPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts from pipeline and navigation canals to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

4.2.2.1.9. Impacts on Endangered and Threatened Fish

4.2.2.1.9.1. Gulf Sturgeon

Potential impacts to the threatened Gulf sturgeon and their designated critical habitat from routine activities associated with a proposed action may occur from drilling and produced-water discharges, degradation of estuarine and marine water quality from runoff, vessel traffic, explosive removal of structures, and pipeline installation. Potential impacts from an accidental oil spill are discussed in **Chapter 4.4.9.1**.

Designated Gulf sturgeon critical habitat occurs in estuarine and riverine locations along the Gulf Coast east of the Mississippi River in Louisiana, Mississippi, Alabama, and Florida (**Chapter 3.2.7.1**). Critical habitat is defined as special geographic areas that are essential for the conservation of a threatened or endangered species and that may require special management and protection. Designated Gulf sturgeon critical habitat is confined to State waters. Most activities related to the proposed action will occur in Federal waters (structure placement, drilling, removal, etc); however, critical habitat may be impacted directly or indirectly.

Proposed Action Analysis

Drilling mud and produced-water discharges contain chemical components that may be detrimental or toxic to Gulf sturgeon. Toxicity from drilling muds would require concentrations four or five orders of magnitude higher than concentrations found a few meters from the discharge point. Produced-water discharges may result in moderate heavy-metal and hydrocarbon contamination of sediments and the water column out to several hundred meters downcurrent from the discharge point (CSA, 1997b). However, offshore discharges of drilling muds and produced waters are expected to dilute to background levels within 1,000 m (3,281 ft) of the discharge point. These structures will be located well offshore of the designated critical habitat. Sturgeon are not known to be attracted to petroleum structures or activity, which is where the discharges would be the most concentrated.

Minor degradation of estuarine water quality is expected in the immediate vicinity of shore bases and other OCS-related facilities as a result of routine effluent discharges and runoff. Rapid dilution is expected to negate any impact to critical habitat or Gulf sturgeon from these sources.

Service-vessel traffic running in and out of shore bases may create the potential for impact to Gulf sturgeon. Major shipping channels, as identified on standard navigation charts and marked by buoys, are excluded from critical habitat designation. Because Gulf sturgeon are bottom-feeders and are not known to be attracted to areas of activity or disturbance, the probability of a take due to vessel strike is extremely low. Dredging of navigation channels and other areas is an impact to Gulf sturgeon critical habitat. However, only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

Platform removal using explosives has the potential to injure or kill a Gulf sturgeon in the near vicinity of a blast. However, current data indicate that Gulf sturgeon generally remain in the estuarine regions near river mouths or in shallow Gulf waters. Critical habitat is in State waters, well inshore of the location of any oil or gas structure installed as a result of the proposed action. In the very unlikely event that a Gulf sturgeon was far enough offshore to be in the area of an impending structure removal, the associated disturbance and activity is expected to deter the fish from approaching the removal site.

Pipeline installation may have the greatest potential for impact to Gulf sturgeon and their critical habitat from a proposed action. Typical methods to lay pipeline can result in bottom and sediment disturbance, burial of submerged vegetation, reduced water clarity, reduced light penetration, and the resulting reduction of seagrass cover and productivity. With these methods, it is assumed that about 5 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 50-850 km (31-528 mi) of pipelines in water depths less than 60 m (200 ft). Such activity would impact the nearshore critical habitat of Gulf sturgeon. However, all of the gas production and most of the oil production from a proposed action in the CPA is expected to be mingled in pipelines with other OCS production at sea before going ashore, and most will use pipelines already in place. Zero to one pipeline landfall is projected as a result of a proposed action in the CPA. Should one be constructed, it will most likely be in Louisiana, where the large majority of the infrastucture exists for receiving oil and gas from the CPA. This area is on the extreme western end of the designated critical habitat for Gulf sturgeon.

Trenchless, or directional, drilling is a recent technique for pipeline installation that is used in sensitive habitats. Impacts from this technique are limited to the access and staging sites for the equipment, and Gulf sturgeon are expected to avoid lay-barge equipment as well as resuspended sediments. This method has been used successfully to place pipelines under scenic rivers so as not to disturb the bottom water or impact the banks of the river. Since 2002, only one new pipeline (Endymion oil pipeline) has come to shore in Louisiana from OCS-related activities. Based on a review of the data in the COE permit application, the emplacement of the pipeline caused zero (0) impacts to marshes and beaches because of the use of horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Pipeline permit requirements of the COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation. These requirements, along with directional drilling capability, will result in impacts to Gulf sturgeon critical habitat that are short term and negligible, if they occur at all.

Summary and Conclusion

Potential impacts on Gulf sturgeon and the designated critical habitat may occur from drilling and produced-water discharges, degradation of estuarine and marine water quality by nonpoint runoff from estuarine OCS-related facilities, vessel traffic, explosive removal of structures, and pipeline installation. The dilution and low toxicity of this pollution is expected to result in negligible impact of a proposed action on Gulf sturgeon. Vessel traffic will generally only pose a risk to Gulf sturgeon when leaving and returning to port. Major navigation channels are excluded from critical habitat. The Gulf sturgeon characteristics of bottom-feeding and general avoidance of disturbance make the probability of vessel strike extremely remote. Explosive removal of structures as a result of a proposed action will occur well offshore of Gulf sturgeon critical habitat and the riverine, estuarine, and shallow Gulf habitats where sturgeon are generally located. Environmental permit requirements and recent techniques for locating pipelines will result in very minimal impact to Gulf sturgeon critical habitat if any pipeline is installed nearshore due to a proposed action. Impacts from routine activities resulting from a proposed action in the CPA are expected to have negligible effects on Gulf sturgeon and their designated critical habitat.

4.2.2.1.10. Impacts on Fish Resources and Essential Fish Habitat

Effects on fish resources and essential fish habitat (EFH) from activities associated with a proposed action could result from coastal environmental degradation, marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from routine activities resulting from a proposed action in the CPA on fish resources and EFH are described below. Potential effects on the habitats of particular concern for CPA fish resources (the 8 newly designated topographic feature HAPC's, Weeks Bay National Estuarine Research Reserve, and Grand Bay) are included under the analyses for topographic features (**Chapter 4.2.2.1.4.1.2**) and wetlands (**Chapter 4.2.2.1.3.2**) respectively. Potential effects from accidental events (blowouts and spills) are described in **Chapter 4.4.10**. Potential effects on commercial fishing from a proposed action are described in **Chapter 4.2.2.1.11**.

Healthy fish resources and fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described in **Chapter 3.2.8**) for managed fish species in the

CPA, the EFH for the GOM includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of fish species within the CPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas, Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (**Chapters 4.2.2.1.3.2 and 4.4.3.2**). These activities include construction of new onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (**Chapters 4.2.2.1.2.1 and 4.4.2.1**) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species within the CPA are dependent on offshore water and a variety of specific bottom types including hard substrate, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the CPA are listed in **Table 3-3**. A detailed discussion of artificial reefs appears in **Appendix A.4.**

A total of 17 named topographic features are now located in the CPA. Eight banks in the CPA were recently designated as HAPC in GMFMC (2005): Alderdice, Bouma, Bright/Rezak, Geyer, Jakkula, McGrail, Sonnier, and Rezak/Sidner. Two HAPC's include multiple topographic features: the Rankin Banks and Bright Bank are separated by several miles, and Rezak and Sidner Banks are physically separate features but combined into a single HAPC in GMFMC (2005).

A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations (**Chapter 2.4.1.3.2; Figure 2-1**) would prevent most of the potential impacts from a proposed action on topographic feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills. As the result of recent GOM multibeam bathymetric surveys, it has become known that there are additional areas of sensitive biological habitat near many topographic features but outside of existing MMS-designated No Activity Zones (GMFMC, 2005). Although the Topographic Features Stipulation does not apply to these areas, the new NTL 2004-G05 includes a new category, *Potentially Sensitive Biological Features*, specifically intended to protect these kinds of habitats outside of previously identified areas.

Impact-producing factors from routine offshore activities that could result in marine water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (**Chapter 4.2.2.1.2.2**). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (**Chapter 4.3.1**). Coastal operations could indirectly affect marine water quality through the migration of contaminated coastal waters (**Chapter 4.2.2.1.2.1**).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of all production in a lease block (**Chapter 4.1.1.11**). Seventy percent of the platforms in water depths less than 200 m (656 ft) are removed by severing their pilings with explosives placed 5 m (15 ft) below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). There has been concern over a possible connection between the explosive removal of platforms and a possible impact on overall fish stocks of those species closely associated with structures, particularly red snapper. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA Fisheries Service and has investigated fish death associated with explosive structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the GOM. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the GOM (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but sublethal physiological irritation to fish resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question.

Drilling muds can contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m (3,281 ft), and is usually undetectable at distances greater than 3,000 m (9,842 ft) (Kennicutt, 1995) (**Chapter 4.1.1.4.1**). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. In the recent past, there has been increased media focus on mercury uptake in fish and other marine species (Raines 2001 and 2002). In these newspaper reports, information from MMS's studies was used to support the conclusion that drilling activities and platform structures were responsible for elevated levels of mercury in commercial fish. However, the MMS study referenced (Kennicutt, 1995) was misrepresented, resulting in misleading and incorrect conclusions. An MMS-funded study titled *Gulf of Mexico Offshore Operations Monitoring Experiment* (Kennicutt, 1995) analyzed sediments at three sites in the GOM. Results of this study indicated that mercury levels were slightly elevated in sediments or organisms at one platform site (High Island Block A-389). The average concentration of mercury at High Island Block A-389 was twice as high as the other two platforms. The highest average concentration (0.41 μg/g) was found within 50 m of the platform but decreased to 0.12 μg/g at 100 m (328 ft). Although these concentrations were the highest found, they were low relative to the probable effects level (0.7) believed to cause biological effects. This platform used the relatively rare practice of shunting drilling muds and cuttings to within 10 m (33 ft) of the seafloor to avoid dispersal and prevent impact to the nearby East Flower Garden Bank.

Metal concentrations were measured in tissues for 37 marine species. Fish tissue concentrations were generally low; for example, the average concentration was 0.45 μg/g for all flounder species, 0.39 μg/g all hake species, and 0.24 μg/g for all snapper species. Shrimp had statistically higher tissue concentrations (0.36 μg/g) near platforms than far (0.19 μg/g) from platforms. These values are well below the Federal guidelines set by FDA to protect human health, which is 1 ppm. From the above study results, scientists concluded that platforms do not contribute to higher mercury levels in marine organisms.

A more recent synthesis report on mercury from oil and gas exploration and production by Neff (2002) concluded that the concentration of total mercury in sediments near almost all of the 30 platforms studied in the GOM is at or near natural background concentrations (about 0.1 ppm) and is rarely over 0.5 ppm. In addition, a key finding was that a large number of monitoring studies show that mercury concentrations in seafood from the GOM are similar to those of seafood from other parts of the world, including areas with little or no oil and gas operations. The amount of mercury entering the GOM from all offshore oil and gas facilities contributes only 0.3 percent of the mercury coming from the air and Mississippi River (Neff, 2002). Additional discussion of mercury in drilling muds can be found in **Chapter 4.1.1.4.1**.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids that have a potential to adversely affect fishery resources. Some petroleum and metal contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997c). Gallaway et al. (1981) reported that the produced-water discharge impacts on platform biofouling communities were limited to a distance of 1 m vertically in the water column and 10 m (33 ft) horizontally. No significant levels of trace metals were found in tissues of any platform-associated fish species, including spadefish, sheepshead, blennies and red snapper. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m (3,281 ft) and are undetectable at a distance of 3,000 m (9,842 ft) from the discharge point (Harper, 1986; Rabalais et al., 1991; CSA, 1997c; Kennicutt, 1995).

Proposed Action Analysis

The effects of a proposed action on coastal wetlands and coastal water quality, with the exception of accidental events, are analyzed in detail in **Chapters 4.2.2.1.3.2 and 4.2.2.1.2.1**, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation in this EIS. The effects of a proposed action on offshore live bottoms and marine water quality are analyzed in detail in **Chapters 4.2.2.1.4.1.1 and 4.2.2.1.2.2**, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation in this EIS. The direct and/or indirect effects from coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Coastal Environmental Degradation

A proposed action is projected to increase traffic in navigation channels to and from service bases from Texas to Alabama. This may result in some erosion of wetlands along the channels, particularly in Louisiana. Additional information regarding erosion along navigation channels is provided in the wetland analysis (**Chapters 4.2.2.1.3.2**).

A total of 23-31 new pipeline landfalls are projected in support of a proposed action. Depending on the site of this projected pipeline landfall, the activities associated with the installation could result in localized impacts to the coastal environment including degradation of water quality and potential erosion and loss of wetlands habitat.

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A proposed action in the CPA is projected to contribute about 3-4 percent of the OCS-Program-related use of these facilities.

Maintenance dredging of waterways and channels would result in decreased water clarity and some resuspension of contaminants. This could preclude, in rare instances, uses of those waters directly affected by the dredging operations for up to several months. The periods between projected dredging operations, ranging from 1-2 years, should generally allow for the recovery of affected areas. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH. Wetlands that could be impacted for some period of time or converted to open water are discussed in the wetlands analysis (**Chapter 4.2.2.1.3.2**). Recovery of fish resources or EFH can occur from more than 99 percent, but not all, of the potential coastal environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation and most EFH can recuperate quickly, but the loss of wetlands as EFH could be permanent. At the expected level of effect, the resultant influence on fish resources or EFH from a proposed action would be negligible and indistinguishable from natural population variations.

Marine Environmental Degradation

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations would prevent most potential impacts from a proposed action on pinnacle-trend live-bottom or topographic-feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills resulting from a proposed action. The application of the new category of *Potentially Sensitive Biological Features* in NTL 2004-G05 will also serve to prevent impacts to hard-bottom EFH habitat associated with topographic features that may lie outside previously defined No Activity Zones. For any activities associated with a proposed action, USEPA's Region 6 will regulate discharge requirements for the CPA through their NPDES permits. Contaminant levels in the CPA are generally low, reflecting the lack of pollution sources and high-energy environment of much of the region. The primary water quality impact from any increased turbidity would be decreased water clarity. Bottom disturbance from structure emplacement operations associated with a proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants.

The major sources of routine discharges to marine waters associated with a proposed action are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Both of these discharges contain various contaminants of concern (e.g., trace metals and petroleum-based organic) that may have environmental consequences on localized marine water quality and aquatic life. Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m (3,281 ft) of the discharge point. Produced-water discharges contain components and properties potentially detrimental to fish resources. Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m (3,281 ft) of the discharge point.

The projected total number of platform installations resulting from a proposed action in the CPA is 28-39 for all water depths. Almost immediately after a platform is installed, the structure would be acting as an artificial reef. After just a few years, many of the fish species present would be residents and not new transients from nearby live bottoms. Reef-building corals have been recently documented colonizing numerous platforms after approximately 10 years in areas with high year-round water quality (Sammarco et al., 2004). Black corals (antipatharians) have also been reported on some structures (Boland and Sammarco, 2005). Structure emplacements can act as FAD's and can result in aggregation of highly migratory fish species. A number of commercially important highly migratory species, such as tunas and marlins, are known to congregate and be caught around FAD's. The attraction of pelagic highly migratory species to offshore structures will likely occur to some degree. Some positive impacts to commercial fishing resulting from fish aggregating around deepwater structures may be possible.

All structures associated with a proposed action are expected to be decommissioned by 2046. It is expected that the number of structures converted to artificial reefs after decommissioning (rigs to reefs) will increase over time. Since the inception of the program, a total of approximately 250 platforms have been converted to artificial reefs. Structure removal results in artificial habitat loss and causes fish kills when explosives are used. Most multi-leg platforms in water depths less than 156 m are removed by severing their pilings with explosives placed 5 m (15 ft) below the seafloor. It is projected that 14 structures in water depths <200 m (656 ft) in the CPA will be removed using explosives as a result of a proposed action. It is expected that structure removals would have a negligible effect on fish resources because these activities kill only those fish proximate to the removal site.

The projected length of pipeline installations for a proposed action is 150-1,700 km (93-435 mi) for all water depths. Trenching for pipeline burial has the potential to adversely affect fish resources. It is assumed that 5.02 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 50-850 km (31-528 mi) of pipelines in water depths less than 60 m (197 ft). Where pipeline burial is necessary, a jetting sled is generally used. Water jets are directed downward to dig a trench and the apparatus can lay pipe at an average of 1.6 km/day (1.0 mi/day) (see **Chapters 4.1.1.3.8.1 and 4.1.2.1.7** for additional discussion of pipelaying activities). Sandy sediments would be quickly redeposited within 400 m (1,312 ft) of the trench or blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters (yards) over a period of 30 days or longer. Any affected population is expected to recover to predisturbance condition in one generation. At the expected level of impact, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations.

It is expected that marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations. Recovery of fish resources or EFH can occur from 100 percent of the potential marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation. Offshore live bottoms, including "pinnacles" and topographic features, are not expected to be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by USEPA NPDES permits. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

Summary and Conclusion

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms, including both pinnacle trend features and topographic features, will experience little or no impact. Live bottoms within No Activity Zones will be completely avoided by all impacting activities. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

Additional hard substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase fish populations. Removal of these structures will eliminate that habitat except when decommissioning results in platforms being used as artificial reef material. This practice is expected to increase over time.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

4.2.2.1.11. Impacts on Commercial Fishing

Effects on commercial fishing from activities associated with a proposed action could result from installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, subsurface blowouts, pipeline trenching, and petroleum spills. Potential effects from routine activities resulting from a proposed action in the CPA on fish resources and EFH are described in **Chapter 4.2.2.1.10**. Potential effects from accidental events (spills and blowouts) are described in **Chapter 4.4.10**. Potential effects on commercial fishing from routine activities resulting from a proposed action are described below.

Since the majority of the commercial species harvested within the CPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality.

Wetlands and estuaries within Texas, Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (**Chapters 4.2.2.1.2.3 and 4.4.3.2**). These activities include construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (**Chapters 4.2.2.1.2.1 and 4.4.2.1**) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species harvested within the CPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the CPA are listed in **Table 3-3**. A detailed discussion of artificial reefs appears in **Appendix A.4**. A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations (**Chapter 2.4.1.3**) would prevent most of the potential impacts from a proposed action on live-bottom communities/EFH from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills. The NTL 2004-G05 includes an additional category of protected features, *Potentially Sensitive Biological Features*, which will serve to protect unnamed or yet-to-be discovered habitat areas outside named topographic feature No Activity Zones or the pinnacle trend blocks of the WPA.

Impact-producing factors from routine offshore activities that could result in degradation of marine water quality include platform and pipeline installation, platform removal, and the discharge of operational wastes (**Chapter 4.2.2.1.2.2**). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter marine water quality (**Chapter 4.3.1**). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (**Chapter 4.4.2.1**).

The area occupied by structures, anchor cables, and safety zones associated with a proposed action would be unavailable to commercial fishermen and could cause space-use conflicts (**Chapter 4.1.1.3.3.2**). Exploratory drilling rigs would spend approximately 30-150 days onsite and would cause short-lived interference to commercial fishing. A bottom-founded, major production platform in shallow water, with a surrounding 100-m (328-ft) navigational safety zone, requires approximately 3 ha (7 ac) of space. A major production facility in deep water (over 1,000 ft/305 m) could obtain special USCG safety zone designation with a 500-m (1,640-ft) radius exclusion zone for vessels larger than 100 ft (30.5 m) in length requiring 78 ha (193 ac) of space. The use of FPSO's is not projected for a proposed action in less than 800 m (2,625 ft), but it is projected in depths over 800 m (2,625 ft). The USCG has not yet determined what size of a navigational safety zone would be required for an FPSO during normal or offloading operations. Any designated safety zone would restrict commercial fishing activities.

Underwater OCS obstructions, such as pipelines, can cause loss of trawls and catch, business downtime, and vessel damage. Pipelines in water depths less than 61 m (200 ft) are required to be buried, and their locations made public knowledge. Although Gulf fishermen are experiencing some economic loss from gear losses, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear losses are covered by the Fishermen's Contingency Fund (FCF) (**Chapter 1.3**).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of all production in a lease block (**Chapter 4.1.1.11**). Seventy percent of the platforms in water depths less than 200 m (656 ft) are removed by severing their pilings with explosives placed 5 m (15 ft) below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). There has been concern over a possible connection between the explosive removal of platforms and a possible impact on overall fish stocks of those species closely associated with structures, particularly red snapper. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA and its NOAA Fisheries Service and has investigated fish death associated with explosive structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the GOM. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the GOM (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small, and would not alter current determinations of stock status or current management recovery strategies.

Chronic, low-level pollution is a persistent condition, resulting in frequent but sublethal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected. The geographic range of the effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource.

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m (3,281 ft), and is usually undetectable at distances greater than 3,000 m (9,842 ft) (Kennicutt, 1995) (**Chapter 4.1.1.4.1**). A recent synthesis report on mercury from oil and gas exploration and production by Neff (2002) concluded that the concentration of total mercury in sediments near almost all of the 30 platforms studied in the GOM is at or near natural background concentrations (about 0.1 ppm) and is rarely over 0.5 ppm. Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. From the above study results, scientists concluded that platforms do not contribute to higher mercury levels in marine organisms.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m (3,281 ft) and are undetectable at a distance of 3,000 m (9,842 ft) from the discharge point (Harper, 1986; Rabalais et al., 1991; CSA, 1997c; Kennicutt, 1995).

Proposed Action Analysis

Installation of offshore structures may cause space-use conflicts with commercial fishing activities. The total projected number of production structure installation for a proposed action ranges from 28 to 39. Using the 500-m (1,640-ft) navigational safety zone figure (although to date very few operators have elected to apply to the USCG for a safety zone around production platforms), the possible area excluded from commercial trawl fishing or longlining would be approximately 78 ha (193 ac). A navigational safety zone does not necessarily exclude all commercial fishing if vessels are less than 100 ft in length. The excluded area represents only a very small fraction of the total area of the CPA.

In water depths less than 200 m (656 ft), the area of concentrated bottom trawl fishing, 22-24 platforms would be installed under a proposed action, eliminating 132-144 ha (326-356 ac) from the area available for commercial fishing. There is no use of FPSO's projected for a proposed action in less than 800 m (2,625 ft). The effect of space loss to trawl fishing resulting from the construction of platforms in support of a proposed action in the CPA would be negligible; the maximum extent of the area lost to commercial trawling would be less than 0.01 percent of the available trawl fishing area in water depths less than 200 m (656 ft).

Two large areas in the DeSoto Canyon Area have been designated by NOAA Fisheries Service as swordfish nursery areas and are closed to longline fishing activities. The boundaries of the closed areas are described in **Chapter 3.3.1** and are shown on **Figure 3-11**. Only one portion of the two closed areas includes part of the CPA. The other southeastern box area is located entirely in the EPA; none of that area is currently available for leasing. A small portion of the northern closed area includes 174 blocks in the former CPA in the Mississippi Canyon, Main Pass, Viosca Knoll, and Mobile lease areas. The closed areas cover nearly 845,000 km^2 (326,256 mi^2) and will displace commercial longlining, which may increase activity in the remaining parts of the CPA and possibly the WPA.

Underwater OCS obstructions such as pipelines may cause fishing gear loss and additional user conflicts. The area of concentrated bottom trawl fishing is in water depths less than 200 m (656 ft). For a proposed action, it is projected that 50-850 km (31-528 mi) of pipeline will be installed in water depths less than 60 m (197 ft); no projection of the length of installed pipelines has been made for water depths of 60-200 m (197-656 ft). Gear loss and user conflicts are mitigated by the FCF. Direct payments for claims in FY 2003 totaled $107,989 and total payments for FY 2004 were $187,429. The amount available for FCF claims in FY 2005 is $1,141,938, but final settlement data has not been posted at this writing. The majority of claims are resolved within six months of filing. The economic loss from gear loss and user conflicts has historically been less than 0.1 percent of the same year's value of Gulf commercial fisheries landings. It is assumed that installed pipelines will seldom conflict with bottom trawl or other fishing activities, and they are expected to have a negligible effect on commercial fishing.

Structure removals result in loss of artificial-reef habitat and cause fish kills when explosives are used. It is projected that 14 structure removals using explosives will occur in water depths of <200 m (656 ft) as a result of each proposed sale action. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys will occur in both shallow and deepwater areas of the CPA. Usually, fishermen are precluded from a very small area for several days. The common fishing practices in the GOM include bottom trawling, purse netting, bottom longlining, and surface longlining. These fishing practices are the most vulnerable to conflicts because they not very mobile and use gear types that require considerable time to deploy and retrieve. It is now well documented that intense sounds such as those produced by seismic airguns affect the spatial distribution of fishes during and following exposure, thus affecting the commercial catch by trawl or hook-and-line within the exposure area and for a certain period post-exposure. Løkkeberg (1991) and Engås et al. (1993) both reported that the cod catch (by trawl) was reduced (80% to 50% reduction) during and following seismic shooting in the North Sea off the coast of Norway. The calculated sound pressure levels received by the fish were 191 and 160 dB, respectively. In the Pacific, off the coast of California, Skalski et al. (1992) found that calculated received levels of 161 dB caused rockfish (*Sebastes* sp.) to change behavior and to show alarm reactions at 180 dB and startle reactions at 200-205 dB. Reduced catch by hook-and-line could be caused by fish moving away or changing feeding behaviors. In any case, there are sufficient observations in the literature to conclude that airgun shooting may cause a temporary reduction in the commercial fish catch within at least several kilometers of the ensonified area. The claim that seismic survey sounds will damage fish ears in the wild is a different question.

There has been some concern about the impact of seismic sounds affecting the ears of fish. The single paper referred to most frequently (McCauley et al., 2003) used conditions and exposures very different than what would be experienced in natural environments. In McCauley et al. (2003) pink snapper (*Pagrus auratus*) were held in cages as small as 1 m^3 in a bay with an average depth of only. The captive fish were approached by the seismic airgun source as close as 5 m (15 ft) a total of seven times with a peak pressure every pass of over 180 dB. These conditions would likely never be experienced by fish in the wild. As acknowledged in the paper, it would be likely that fish would swim away from the airgun source as it approached if possible as demonstrated in other research (Engås et al., 1993). Although the fish ear epithelia showed damage apparently related to the sound impacts (a mean of 2.7% missing ear hair cells compared to total number), there was no indication what level was required to produce the damage observed or if recovery would have occurred after sacrificing all the test animals after 58 days.

To state it simply, there is virtually no chance that any fish species will follow or somehow be restricted to within a few meters of seismic air-gun sources for multiple exposures of over 180 dB of pressure waves. Temporary presence of seismic surveys should not impact the annual landings or value of landings for commercial fisheries in the Gulf. GOM species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Loss of fishing gear because of seismic surveys is also mitigated (see above) by the FCF. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners*, a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

Summary and Conclusion

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Seismic surveys are not expected to cause long-term or permanent displacement of any listed species from critical habitat/preferred habitat or to result in destruction or adverse modification of critical habitat or essential fish habitat. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations because of natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

4.2.2.1.12. Impacts on Recreational Fishing

This section discusses the possible effects of the proposed action on recreational fishing. Impact-producing factors associated with a proposed lease sale that could directly impact recreational fishing in the offshore environment include the presence of offshore structures, pipeline installation activities, and oil spills. Potential effects from accidental events including oil spills on recreational fishing are described in **Chapter 4.4.11.**

Recreational fishing could be indirectly impacted by adverse effects of a proposed action on fish stocks or EFH. The analyses of the potential impacts of a proposed action on fish resources and EFH (**Chapter 4.2.1.1.8**) and potential impacts on commercial fisheries (**Chapter 4.2.1.1.9**) also apply to the proposal's indirect impacts on recreational fishing. The analysis of fish populations is particularly relevant to recreational fishing impacts.

As indicated in **Chapter 3.3.2.**, marine recreational fishing along Florida's west coast, and coastal Alabama, Mississippi, and Louisiana is very popular with both residents and tourists, and it is economically important to these coastal states. The latest information from the NMFS Marine Recreational Fisheries Statistics Survey (USDOC, NMFS, 2002) indicates there were almost 2 million resident participants in GOM saltwater fishing from Louisiana to Florida and a similar number of out-of-state (tourist) fishermen. Of these resident and tourist fishermen from Louisiana to Florida, an estimated 1.9 million offshore fishing trips occurred in Federal waters (>10 mi off Florida's west coast and >3 mi off Alabama, Louisiana, and Mississippi) during 2001 (USDOC, NMFS, 2002b). The greatest number of fish caught and landed from this offshore zone included dolphins, grunts, jacks, porgies, groupers, snappers, and mackerels. Likewise, a significant amount of effort is expended by a specialized group of big game or billfish fishermen seeking primarily tuna, marlin, and wahoo focused in deep offshore waters from south of the Mississippi Delta to the DeSoto Canyon off northwest Florida.

A significant proportion of the U.S. fishing industry is located in the Gulf of Mexico. Thirty percent (approximately 26 million trips in 2004) of all saltwater recreational fishing trips occur in this region (USDOC, NMFS, 2004). In 2001, 2.9 million anglers spent approximately 30 million days saltwater fishing. They generated $3 billion in retail sales annually, that in turn, produced $5.7 billion in economic output and supported 57,535 jobs (Roussel, 2005). Hurricanes Katrina and Rita impacted recreational fishing from the Florida panhandle through Texas. It is estimated that over $1.2 billion was lost due to the hurricanes' impact on recreational fisheries (Roussel, 2005).

The Louisiana Dept. of Wildlife and Fisheries estimates the 12-month retail value of lost sales resulting from the potential disruption of recreational fishing activities at $200 million (Louisiana Dept. of Wildlife and Fisheries, 2005). NOAA (National Oceanic and Atmospheric Association) estimates the hurricane impact on recreational fisheries in Louisiana to be closer to $392 million (NOAA 2005). The damage to artificial reefs, small boats, and charter craft is continuing to be evaluated. However, preliminary data estimate that 3,077 charter/headboats in Alabama, Mississippi, Louisiana, West Coast Florida, and Texas have been damaged by Hurricanes Katrina and Rita (USDOC, NMFS, 2005c). In Mississippi, all fishing piers in the three coastal counties were either completely destroyed or damaged to an extent that that are unsafe (Mississippi Dept. of Marine Resources, Office of Marine Fisheries, 2005).

In Mississippi, over 26% of recreational anglers fishing in Mississippi come from out of State. Recent surveys found that Mississippi anglers spend over $50 million annually on food and beverages, over $9 million on lodging, over $19 million on bait and ice, over $15 million on boat fuel, and over $57 million on fishing tackle (Mannina 2005).

Despite the damage to recreational fishing after the 2005 hurricane season, assessments indicate that many of the most valuable fish stocks in the region remain at or above the previous year's levels. Seafood samples indicate that toxic substances are well below the FDA's guidelines. The lack of infrastructure is one of the largest obstacles to recovery. This is particularly true for commercial harvesters that rely on the supporting infrastructure to operate (e.g., seafood dealers, processors, and suppliers). Other forms of support infrastructure are more closely tied to recreational anglers (e.g., bait shops, marinas, etc.) (Lautenbacher, 2006).

Proposed Action Analysis

The most significant impact of routine operations on recreational fisheries is likely to result from space use conflicts. Placement of MODU's disturbs the seafloor, causes turbidity, and may temporarily drive fishes away from the general area. These activities would primarily affect soft bottom species such as red drum, sand sea trout, and spotted sea trout sought by anglers in private or charter/party vessels. Fishes would, however, eventually return to the disturbed area.

The introduction of high-profile structures, specifically drilling rigs and platforms, into a lease sale area frequented by offshore fishermen is the development activity most likely to affect fish and recreational fishing. About 58.5 percent of all recreational fishing trips made in the eastern and central Gulf (Florida, Alabama, Mississippi, and Louisiana) during 1998 were from private and charter/party vessels (USDOI, MMS, 2001d). About 63 percent of these trips were made in inland waters, with the remainder (37%) of the trips made in inshore or offshore waters of the GOM. The presence of structures would have a FAD effect on pelagic (e.g., king mackerels, tunas, cobia) and reef-associated species (e.g., red snapper, gray triggerfish, amberjack) that would also be attractive to most recreational fishers. Rigs and platforms function as very large *de facto* artificial reefs. They attract and concentrate sport fish and stimulate the growth of marine life, which would also be attractive to fishermen and divers (Bull et al., 1997). Many studies (Ditton and Auyong, 1984; Roberts and Thompson, 1983; Ditton and Graefe, 1978; Dugas et al., 1979) have demonstrated that, when GOM petroleum structures are accessible to marine recreational fishermen and scuba divers, the structures are a major attraction throughout their entire lifetime for marine recreational fishing and are a positive influence on tourism and coastal economics.

Almost all offshore recreational fishing is currently confined within 100 mi (161 km) of shore. Very few fishing trips go beyond the 200-m (656-ft) contour line. The introduction of 22-24 production facilities as a result of a proposed action could attract recreational fishermen to pursue game fish attracted to these structures. Even if production facilities applied for and established 500-m (1,640-ft) safety zones, this would not exclude any recreational fishing vessel less than 100 ft in length. Fishing prospects are likely to improve by those choosing to fish in the immediate vicinity of rigs and platforms.

Oil and gas development and production resulting from this proposal would require the installation of pipelines to gather and transport petroleum products to onshore processing and refining facilities. Short-term, space-use conflict could occur during the time that any pipeline is being installed.

Summary and Conclusion

The development of oil and gas in the proposed lease sale area could attract additional recreational fishing activity to structures installed on productive leases. Each structure placed in the GOM to produce oil or gas would function as a *de facto* artificial reef, attract sport fish, and improve fishing prospects in the immediate vicinity of platforms. This impact would last for the life of the structure, until the structures are removed from the location and the marine environment. A proposed action would have a beneficial effect on offshore and deep-sea recreational fishing within developed leases accessible to fishermen. These effects would last until the production structures are removed from the marine environment. Short-term space-use conflict could occur during the time that any pipeline is being installed.

4.2.2.1.13. Impacts on Recreational Resources

This section discusses the possible effects of a proposed action in the CPA on recreational beaches. Millions of annual visitors attracted to these resources are responsible for thousands of local jobs and billions of dollars in regional economic activity. Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the GOM and that support a multiplicity of recreational activities, most of which are focused at the land and water interface. Included are Gulf Islands National Seashore, State parks and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas.

The general locations of these beaches are indicated on MMS Visual 2—Multiple Use (USDOI, MMS, 2001c).

The primary impact-producing factors to the enjoyment and use of recreational beaches are trash and debris, and oil spills. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation, and noise from OCS-related aircraft can adversely affect a beach-related recreation experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The potential impacts from oil spills and other accidental events are discussed in **Chapter 4.4.12**.

The value of recreation and tourism in the GOM coastal zone from Texas through Florida has been estimated in the tens of billions of dollars annually (USDOI, MMS, 2001a; pages III-101 and III-102). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. Over one million people visit the mainland unit and barrier island beaches of the Gulf Island National Seashore in Mississippi and Florida annually, demonstrating the popularity of destination beach parks throughout the Gulf Coast region east of the Mississippi River. Trash and debris from OCS operations can wash ashore on GOM recreational beaches. Recreational beaches west of the Mississippi River are the most likely to be impacted by waterborne trash from OCS activities. Litter on recreational beaches from OCS operations could adversely affect the ambience of the beach environment, detract from the enjoyment of beach activities, and increase administrative costs on maintained beaches. Some trash items, such as glass, pieces of steel, and drums with chemical residues, can also be a health threat to users of recreational beaches. Current industry waste management practices; training and awareness programs focused on the beach litter problem; and the OCS industry's continuing efforts to minimize, track, and control offshore wastes are expected to minimize potential for accidental loss of solid wastes from OCS oil and gas operations.

The physical presence of platforms and drilling rigs visible from shore, and noise associated with vessels and aircraft traveling between coastal shore bases and offshore operation sites can adversely affect the natural ambience of primitive coastal beaches. Drilling rigs and platforms placed 3-10 mi from shore are within sight range of shoreline recreational beaches. Federal and State oil and gas operations are already occurring on nearshore tracts off Louisiana, Mississippi, and Alabama.

Although these factors may affect the quality of recreational experiences, they are unlikely to reduce the number of recreational visits to coastal beaches in the Central Gulf.

Proposed Action Analysis

A proposed action in the CPA is projected to result in the drilling of 77-88 exploration and production wells and the installation of 20-21 platforms in water depths <60 m (197 ft). In water depths of 60-200 m (197-656 ft), a proposed action is projected to result in 31-38 wells and 2-3 platforms. Marine debris will be lost from time to time from OCS operations associated with drilling activities and production facilities projected to result from a proposed action in the CPA. Waste management practices and training programs are expected to minimize the level of accidental loss of solid wastes from activities resulting from a proposed action. Recreational beaches in Louisiana and Texas are most likely to be impacted by any waterborne trash. Beached litter and debris from a proposed action is unlikely to be perceptible to beach users or administrators because a proposed action would constitute only a small percentage of the total OCS Program activity in the CPA.

A proposed action is expected to result in 117,000-239,000 service-vessel trips over the life of the leases or about 2,925-5,975 trips annually. A proposed action is also expected to result in 1,000,000-2,200,000 helicopter operations (take off and landing), which is about 25,000-55,000 operations annually. Service vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at least 90 percent of the time. This additional helicopter and vessel traffic will add very little noise pollution likely to affect beach users.

Summary and Conclusion

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

4.2.2.1.14. Impacts on Archaeological Resources

Blocks with a high potential for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the Central Gulf. Blocks with a high potential for prehistoric archaeological resources are found landward of the 12,000 B.P. shoreline position, which is roughly approximated by the last geologic still-stand before inundation at approximately 13,000 B.P. This 13,000-B.P. still-stand also roughly follows the 45-m bathymetric contour. Because of inherent uncertainties in both the depth of historic sea level stands and the entry date of prehistoric man into North America, MMS has adopted the 60-m (197-ft) water depth as the seaward extent of the area considered to have potential for prehistoric archaeological resources.

The areas of the northern GOM that are considered to have high potential for historic period shipwrecks were redefined as a result of an MMS-funded study (Pearson et al., 2003; NTL 2006-G07). The 2003 study refined the shipwreck database in the GOM, initially developed by a previous MMS-funded study (Garrison et al., 1989), and identified new areas along the approach to the Mississippi River that have a high potential for containing historic shipwrecks. The Garrison et al. (1989) study used statistical analysis of shipwreck location data to identify two specific types of high-potential areas—the first within 10-km (6-mi) of the shoreline and the second proximal to historic ports, barrier islands, and other loss traps. High-potential search polygons associated with individual shipwrecks were also created to afford protection to wrecks located outside the two aforementioned high-potential areas. The Pearson et al. (2003) study incorporated this model into their recommendations and the historic archaeological high-potential areas are under MMS review at the time of this writing. The MMS requires a 50-m remote-sensing survey linespacing for historic shipwreck surveys in water depths of 200-m (656-ft) or less. The current NTL—NTL 2005-G07, effective July 1, 2005—supersedes all other archaeological NTL's and LTL's, and updates requirements to reflect current technology. The list of lease blocks requiring an archaeological survey and assessment are identified in NTL 2006-G07.

An Archaeological Resources Stipulation was included in all GOM lease sales from 1973 through 1994. The stipulation has been incorporated into operational regulations, which can be found at 30 CFR 250.194. All protective measures offered in the Stipulation have been adopted in this regulation.

Additional supportive material for the archaeological resources analysis is provided in **Chapter 3.3.4** (Description of the Affected Environment) and **Chapters 4.4.13 and 4.5.14** (Environmental Consequences).

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity or anchors having an impact on an historic shipwreck. Direct physical contact with a wreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel’s crew, and the concomitant loss of information on maritime culture for the period from which the ship dates.

The placement of drilling rigs and production systems has the potential to cause physical impact to prehistoric and/or historic archaeological resources. The area of seafloor disturbance from each of these structures is defined in **Chapter 4.1.1.3.2.1** of this EIS. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric and/or historic archaeological resources. Pipelines placed in water depths of less than 61 m must be buried. Burial depths of 1 m are required with the exception of shipping fairways and anchorage areas, where the requirements are 3.0 m and 4.6 m, respectively.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to historic shipwrecks (Espey, Huston, & Associates, 1990a). There are many navigation channels that provide OCS access to onshore facilities. Most of these are located in the Central Gulf.

Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipelaying barge.

Activities resulting from a proposed action will generate ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

4.2.2.1.14.1. Historic

Proposed Action Analysis

The likely locations of archaeological sites cannot be delineated without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS regulations that require OCS lessees and operators and applicants for pipeline rights-of-way to conduct an archaeological survey prior to proposed activities within areas determined to have a high potential for historic and/or prehistoric archaeological resources are described in **Chapter 1.5**. Generally, in the eastern part of the CPA, where unconsolidated sediments are thick, it is likely that side-scan sonar will not detect shipwrecks buried beneath the mud. In this area, which begins nearshore around the Vermilion Area (USDOI, MMS, 1984) and extends eastward, the effectiveness of the survey for detecting historic shipwrecks of composite and wooden construction would depend on the capability of a magnetometer to detect ferromagnetic masses of the size characteristically associated with shipwrecks. It is assumed that the required 50-m line spacing (as specified in NTL 2005-G07) is a highly effective survey methodology, allowing detection and avoidance of historic shipwrecks within the survey area. The survey would therefore minimize the potential impacts to historic shipwrecks.

According to estimates presented in **Table 4-3**, 395-564 exploration, delineation, and development wells will be drilled and 28-39 production platforms will be installed in support of a proposed action. Of these, 108-126 exploration, delineation, and development wells will be drilled, and 22-24 platforms will be installed in water depths of 200 m (656 ft) or less, where the majority of blocks having a high potential for historic period shipwrecks are located. The location of any proposed activity within a lease that has a high potential for historic shipwrecks requires archaeological clearance prior to operations. Considering that the expanded MMS shiprwreck database contains 911 reported shipwrecks in the entire Central Gulf OCS (**Table 3-33**), the probability of an OCS activity contacting and damaging a shipwreck is very low. If an oil and gas structure contacted a historic resource, however, there could be a loss of significant or unique archaeological information.

Because there is only a thin Holocene sediment veneer overlying an overconsolidated Pleistocene surface in the western part of the CPA, shipwrecks are more likely to be detected by side-scan sonar; therefore, the 50-m survey linespacing is expected to be even more effective for reducing the potential for a direct physical contact between an impact-producing factor and a shipwreck in the western CPA. There is a very small possibility that a historic shipwreck could be impacted by OCS activities. Should such an impact occur, however, significant or unique archaeological information could be lost.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. Historic sites that have yet to be identified may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development could result in the direct physical contact between the construction of new onshore facilities or pipeline canals and previously unidentified historic sites. This direct physical contact with a historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. It is assumed that 3-4 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. **Table 4-9** shows the projected coastal infrastructure related to OCS Program activities. Facilities that are projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or communities. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites in the CPA from onshore development.

Maintenance dredging in support of activities resulting from a proposed action has the potential to impact a historic shipwreck. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to impact the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. The MMS assessment indicates that, under a proposed action, less than 1 percent of the ship traffic through the Port Mansfield Cut is related to OCS use. Therefore, the impact to the *Santa Maria de Yciar* and *SS Mary* directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. While the specific example falls within coastal Subarea TX-1, an area unlikely to be affected by activities resulting from a proposed action in the CPA, it serves to illustrate that the potential exists for historic shipwrecks to be impacted by dredging. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. Proposed action activities represent <1 percent of the usage of the major navigation channels for the Central Gulf.

The loss of ferromagnetic debris during exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. Under a proposed action, it is expected that hundreds of tons of ferromagnetic debris will be lost overboard. It is expected that most ferromagnetic debris associated with OCS structures will be removed from the seafloor during site-clearance activities. Site clearance, however, takes place after the useful life of the structure is complete. It has been noted that such debris has the potential to be moved from the area of initial deposition as a result of trawling activities (Garrison et al., 1989). Also, no site-clearance activities are required for pipeline emplacement operations. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and gas activities.

Since all platform locations within the high-potential areas for the occurrence of offshore historic and prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities, Central and Western GOM Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the CPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Pearson et al., 2003) resulted in refinement of the areas assessed as having high-potential areas for the location of historic period shipwrecks. An MMS review of the historic high-potential areas for historic shipwrecks is occurring at the time of this writing. The NTL for archaeological resource surveys in the GOM Region, NTL 2005-G07, mandates a 50-m linespacing for remote-sensing surveys of leases within the areas having high potential for historic shipwrecks in water depths 200 m (656 ft) or less, and 300-m linespacing in water depths greater than 200 m (656 ft). NTL 2006-G07 identifies those lease blocks that have been designated as having a high potential for containing historic shipwrecks.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the CPA are not expected to impact historic archaeological resources. It is conservatively assumed that about 3-4 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action (**Table 4-9**). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the CPA are not expected to affect historic archaeological resources.

4.2.2.1.14.2. Prehistoric

Offshore development as a result of a proposed action could result in an interaction between a drilling rig, a platform, a pipeline, dredging, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenance and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Proposed Action Analysis

According to projections presented in **Table 4-3**, under a proposed action, 395-564 exploration, delineation, and development wells will be drilled, and 28-39 production platforms will be installed as a result of a proposed action in the CPA. Relative-sea-level data for the GOM indicates that there is very low potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m (197 ft). If only the area likely to contain prehistoric sites (shallower than 60 m (197 ft)) is considered, 77-88 exploration, delineation, and development wells and 20-21 production platforms are projected to be installed (**Table 4-3**). The limited amount of impact to the seafloor throughout the CPA, the required archaeological survey, and archaeological clearance are sufficient to assume a low potential for impacting a prehistoric archaeological site. Should such an impact occur, damage to or loss of significant or unique prehistoric archaeological information could occur.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. Prehistoric sites that have yet to be identified would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of a proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. It is assumed that 3-4 percent of the OCS Program’s use of projected onshore facilities will occur as a result of a proposed action. **Table 4-9** shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There should, therefore, be no impact to onshore CPA prehistoric sites from onshore development related to a proposed action.

Each platform location within the areas determined to have high potential for historic and/or prehistoric archaeological resources requires archaeological clearance prior to setting the structure; therefore, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structural Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

Several impact-producing factors may threaten the prehistoric archaeological resources of the Central Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant and/or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the CPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

4.2.2.1.15. Impacts on Human Resources and Land Use

This proposed action analysis considers the effects of OCS-related, impact-producing activities from a proposed CPA lease sale in relation to the continuing baseline of non-OCS-related factors. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity from State waters, offshore LNG activity, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but cannot be predicted are not considered in this analysis.

4.2.2.1.15.1. Land Use and Coastal Infrastructure

Proposed Action Analysis

Chapters 3.3.5.1.2 and 3.3.5.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. Except for the projected 0-1 new gas processing plants, the proposed action will require no new oil and gas coastal infrastructure. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle development. There is also sufficient land to construct the projected new gas processing plant in the analysis area.

The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed CPA lease sale would not alter the current land use of the area.

Summary and Conclusion

A proposed action in the CPA would not require additional coastal infrastructure, with the exception of possibly one new gas processing facility, and would not alter the current land use of the analysis area.

4.2.2.1.15.2. Demographics

In this section, MMS projects how and where future demographic changes will occur and whether they correlate with a proposed CPA lease sale. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions and land use.

Proposed Action Analysis

Population

Population projections related to activities resulting from a proposed action are expressed as total population numbers and as a percentage of the population levels that would be expected if the proposed lease sale were not held (**Tables 4-28 and 4-29**). **Chapter 3.3.5.4.1** discusses baseline population projections for the analysis area through 2030. Because the baseline projections assume the continuation of existing social, economic, and technological trends at the time of the forecast, they also include population changes associated with the continuation of current patterns in OCS Program activities. Population impacts from a proposed action in the CPA mirror the assumptions for employment impacts described in **Chapter 4.2.2.15.3** below. Projected population changes reflect the number of people dependent on income from OCS-related employment for their livelihood (e.g., family members of oil and gas workers), which is based on the ratio of population to employment in the analysis area over the life of a proposed lease sale. The population projections due to a proposed CPA sale are calculated by multiplying the employment projections (**Chapter 4.2.2.1.15.3**, Economic Factors, and **Tables 4-30 and 4-31**) by a ratio of the baseline population (**Table 3-35**) to the baseline employment (**Table 3-41**). Note that EIA's LA-1, LA-2, LA-3, LA-4, MA-1, and AL-1 correspond to the offshore CPA; TX-1, TX-2, and TX-3 correspond to the WPA; and FL-1, FL-2, FL-3 and FL-4 correspond to the EPA.

Population associated with a proposed CPA lease sale is estimated at about 13,007-31,473 persons during the peak year of impact (year 5) for the low- and the high-case scenarios, respectively. While population associated with a typical CPA lease sale as proposed is projected to peak in year 5, years 2 and 3 also display higher levels of population. During the years of peak or near-peak population, a substantial amount of platform and pipeline installations are projected in association with a proposed CPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, therefore, leading to employment and population impacts.

Population impacts from a proposed action in the CPA are expected to be minimal, i.e., less than 1 percent of total population for any EIA. The mix of males to females is expected to remain unchanged. The increase in employment is expected to be met primarily with the existing population and available labor force with the exception of some in-migration (some of whom may be foreign) projected to move into focal areas, such as Port Fourchon.

Age

If a proposed CPA lease sale is held, the age distribution of the analysis area is expected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed in **Chapter 3.3.5.4.2** is expected to continue through the year 2046. Activities relating to a proposed action in the CPA are not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged if a proposed CPA lease sale is held. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in **Chapter 3.3.5.4.3** is expected to continue through the year 2046 (See **Chapters 3.3.5.4.1 and 3.3.5.4.3** for a discussion of race and ethnic composition changes as a result of Hurricanes Katrina and Rita).

Summary and Conclusion

Activities relating to a proposed CPA lease sale are expected to affect minimally the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one EIA. Baseline patterns and distributions of these factors, as described in **Chapter 3.3.5.4**, are expected to approximately maintain the same level. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

4.2.2.1.15.3. Economic Factors

The oil and gas industry is significant to the coastal communities of the GOM, particularly in south Louisiana and eastern Texas. The economic analysis for a proposed lease sale in the CPA focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the analysis region defined in **Chapter 3.3.5.5.1**. To improve regional economic impact assessments and to make them more consistent across planning areas, MMS developed a new model called MAG-PLAN for estimating changes to employment and other economic factors (Saha et al., 2005). The MAG-PLAN retains the two-stage process of the older MMS models. The first-stage estimates the expenditures required to support the activity levels in a specific exploration and development scenario, and allocates these expenditures to the various industrial sectors in the onshore geographic units of interest. The activities are meant to be comprehensive, including exploration drilling, platform fabrication and installation, pipeline construction and installation, and various other construction and maintenance functions required to support the phases of development. The proposed action scenario (**Tables 4-1 and 4-3**) is an estimate of the oil- and gas-related activities that could plausibly take place as the result of a proposed action. High- and low-range estimates of activity drawn from this scenario form the basis for a range of estimates of employment and personal income effects.

The second step in the process estimates how the initial dollars spent in a geographic area reverberate through the economy. Stage II of MAG-PLAN uses multipliers taken from the widely used IMPLAN model to estimate the employment, income, and other economic effects. For each of these economic effects, the model estimates direct, indirect, induced, and total effects. In standard usage, the direct effects would refer to the spending of the oil and gas industry as a result of the projects being analyzed, as well as the employment, income, and other such effects caused by that spending. Indirect effects are those that arise from subsequent rounds of spending by contractors, vendors, and other businesses. Induced effects arise from the spending of worker households. However, while total effects remain the same, most "direct" MAG-PLAN estimates include the first round of indirect and induced effects. The MAG-PLAN direct effects can be thought of as the effects of local payroll and non-payroll expenditures of oil and gas companies, as well as of their immediate suppliers.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably by the phase of OCS activity and by the water depth of the OCS activities. For example, an exploratory well in 0-60 m (0-197 ft) of water is expected to cost significantly less than a similar well in 800 m (2,625 ft) or greater water depth to complete. In addition, spending on materials such as steel will be much higher for platform fabrication and installation than for operations and maintenance once production begins. Therefore, the model estimates and allocates expenditures for the scenario activities in seven water-depth categories: 0-60 m (0-197 ft); 61-200 m (197-656 ft); 201-400 m (659-1,312 ft); 401-800 m (1,316-2,625 ft); 801-1,600 m (2,628-5,249 ft); 1,601-2,400 m (5,253-7,874 ft); and over 2,400 m (7,874 ft). In addition, the model estimates and allocates expenditures for both drilling scenario activities (exploratory, production, and nonproduction wells drilled) and workovers by three well-depth categories for each of the seven water-depth categories. Because local economies vary, a separate set of IMPLAN multipliers is used for each EIA to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in the number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

The projections in this section are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Energy projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated, including severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Given this, MMS has endeavored to make these projections as objective, reliable, and useful as possible.

Proposed Action Analysis

Total employment projections for activities resulting from a proposed action are expressed as absolute numbers and as a percentage of the baseline employment projections described in **Chapter 3.35.5** and presented in **Tables 4-30, 4-31, and 4-32**. The baseline projections for EIA's LA-1, LA-4, and MS-1 incorporate the employment projections for the counties and parishes most negatively impacted by Hurricanes Katrina and Rita that were discussed in **Chapter 3.3.5.5** (**Table 3-34**). Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities.

Population impacts, described in **Chapter 4.2.1.14.2** (**Tables 4-28 and 4-29**), mirror those assumptions associated with employment. Based on model results, direct employment associated with a proposed CPA lease sale is estimated at about 4,150-9,950 jobs during the peak impact year for the low- and high-case scenarios, respectively. Indirect employment is projected at about 1,400-3,550 jobs, while induced employment is calculated to be about 1,950-4,550 jobs, for the low- and high-case scenarios, respectively. Therefore, total employment resulting from a proposed CPA lease sale is not expected to exceed 7,500-18,050 jobs in any given year over a proposed action's 40-year lifetime. However, a portion of these employment estimates do not represent "new" jobs. Many of these jobs would represent new contracts or orders at existing firms. These contracts would essentially keep the firm operating at its existing level as earlier contracts and orders are completed or filled. In other words, a portion of these 7,500-18,050 jobs would be staffed with existing company labor force and would simply maintain the status quo. Thus, these employment estimates should be considered to overestimate the actual magnitude of new employment effects from the proposed action.

Most of the employment related to a proposed CPA action is expected to occur in Texas (EIA TX-3) and Louisiana (EIA's LA-2 and LA-3). Considering Florida's current opposition to oil and gas development in offshore waters and the scarcity, if not absence, of onshore supporting service bases, MMS anticipates that very few OCS-related activities will be staged from Florida. Current model results seem to project more employment in the early years than anticipated based on previous experience. In addition, model results for direct, and hence total, employment in Florida may be too high due to the existing methodology used to allocate expenditures onshore for the state. The MMS will reexamine these results in the Final EIS. Although most of the employment related to a proposed CPA action is expected to occur in EIA TX-3, employment is not expected to exceed 1 percent of the total employment in any given EIA of Texas, Louisiana, Mississippi, Alabama, or Florida (**Table 4-32**). On a percentage basis, EIA LA-2 is projected to have the greatest employment impact at 0.8 percent; EIA LA-3 is projected to have the next greatest employment impacts at 0.5 percent; and EIA's LA-4 and TX-3 are projected to have employment impacts at 0.2 percent each.

Summary and Conclusion

Should a proposed CPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, Alabama, and Florida EIA's. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force for reasons discussed above.

4.2.2.1.15.4. Environmental Justice

The analysis of environmental justice concerns is divided into those related to routine operations (below) and those related to oil spills (**Chapter 4.4.14.4**). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). **Chapter 3.3.5** describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities. The MMS estimates that production from a proposed action in the CPA will be 0.776-1.292 BBO and 3.236-5.229 Tcf of gas.

Proposed Action Analysis

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. A proposed action in the CPA is expected to increase slightly employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. **Figures 3-21 through 3-26** display the geographic distribution of low income and minority residents across Gulf counties and parishes. As stated in **Chapter 3.3.5.10** and displayed in **Figures 3-21 through 3-26**, there are communities that could exhibit disproportionate effects on low income or minority groups in the region. Ten counties (or parishes in Louisiana) are considered to have a high concentration of oil-related infrastructure (**Table 3-40**). Of these 10 counties, 5 have higher minority percentages than their respective State average.

These counties are Mobile, Alabama; St. Mary, Louisiana; and Galveston, Harris, and Jefferson, Texas. Only 2 of the 10 high infrastructure concentration counties also have higher poverty rates than their respective State poverty rate. Both St. Mary Parish, Louisiana, and Jefferson County, Texas, have higher poverty rates than the mean poverty rates in their states. Many of these low income and minority populations are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of industry activity, effects of a proposed action are not expected to be disproportionate.

The widespread economic effects of a proposed action on minority and low-income populations are expected to be mostly positive. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector; therefore, it affected white male employment more than that of women or minorities (Singelmann, personal communication, 2006). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an OCS-related plant in one rural town were much higher than reemployment rates related to similar closings elsewhere because Louisiana’s oil industry had created a complex local economy (Tobin, 2001). While a proposed action will provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice concerns often arise from the possible siting of infrastructure in places that will have disproportionate and negative effects on minority and low-income populations. Since a proposed action will help to maintain ongoing levels of activity rather than expand them, no one proposed lease sale will generate new infrastructure demand sufficient to raise siting issues. For this reason, this EIS considers infrastructure projections only for the cumulative analysis (**Chapter 4.5.15.4**). The cumulative analysis concludes that, as with the analysis of employment effects of a proposed action, infrastructure effects are expected to be widely and thinly distributed. Since the siting of new infrastructure will reflect the distribution of the petroleum industry and not that of minority and low-income populations, the OCS activity in the CPA is not expected to disproportionately affect these populations. Again, Lafourche Parish is identified as a location of more concentrated effects. Each OCS-related facility constructed onshore must first receive approval by the relevant Federal, State, county or parish, and community involved, and MMS assumes that new construction will be approved only if consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Because of Louisiana’s extensive oil-related support system (**Chapter 3.3.5.8**), that State is likely to experience more employment effects related to a proposed action in the CPA than are the other coastal states. Lafourche Parish, Louisiana, is likely to experience the greatest concentration and is the only parish where the additional OCS-related activities and employment are sufficiently concentrated to increase stress to its infrastructure. Even so, the effects of a proposed action are not expected to be significant in the long term.

The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately minority or low income (**Figures 3-22 and 3-25**). The Houma, a Native American tribe recognized by the State of Louisiana, has been identified by MMS as a possible environmental justice concern.

New MMS research indicates that minority populations throughout Lafourche Parish, Louisiana, could sustain disproportionate effects should a major accident involving onshore activities occur (Hemmerling and Colten, 2003). Five different classes of relevant OCS activities exist in the region, including transportation corridors, oil and natural gas pipelines, petroleum bulk storage facilities, shipyards, and a natural gas processing plant. The majority of OCS-related infrastructure is located in south Lafourche Parish where the Houma Indian population is concentrated. A proposed CPA lease sale would not significantly alter this preexisting situation where onshore cumulative effects already exist.

Therefore, since the preexisting situation would not be significantly altered, minority and low-income populations would not sustain disproportinate adverse effects from the proposed action.

A reevaluation of the baseline conditions pertaining to environmental justice was recently conducted as a result of recent hurricane activity in the GOM. While it is expected that hurricane activity can have severe impacts on all coastal communities, impacts on minority and low-income populations may be disproportionate to the remainder of the local population. Since the hurricanes have not forced a major shifting of the onshore infrastructure and the proposed action would predominately use existing infrastructure, no difference from the existing conditions will be evident.

Two local infrastructure issues described in **Chapter 3.3.5.2** could possibly have related environmental justice concerns—traffic on LA Hwy. 1 and the Port Fourchon expansion. The most serious concern raised during scoping for this multisale EIS is the high-level of traffic on LA Hwy. 1. Increased traffic may have health risks (e.g., increased accident rates). As described in **Chapter 3.3.5.2**, human settlement patterns in the area (on high ground along LA Hwy. 1 and Bayou Lafourche) mean that rich and low-income alike would be affected by any increased traffic. Port Fourchon is relatively new and is surrounded by mostly uninhabited land. Existing residential areas close to the port are also new and not considered low-income areas. Any expansion of infrastructure at Port Fourchon is not expected to disproportionately affect minority or low-income populations. Lafourche Parish is an area of relatively low unemployment because of the concentration of petroleum-related industry in the area (Hughes, in press). While the minority and low-income populations of Lafourche Parish will share with the rest of the parish population any negative impacts related to a proposed action in the CPA, most effects related to a proposed action would be economic and positive.

Summary and Conclusion

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a proposed action in the CPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on these populations.

Lafourche Parish will experience the most concentrated effects of a proposed action; however, because the Parish is not heavily low-income or minority, because the Houma are not residentially segregated, and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups will not be differentially affected. In general, the effects in Lafourche Parish are expected to be mostly economic and positive. A proposed action would help to maintain ongoing levels of activity rather than expand them. Future changes in activity levels will most likely be caused by fluctuations in oil prices and imports, and not by activities related to a proposed action. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.2.2.2. Alternative B – The Proposed Actions Excluding the Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (proposed action) by not offering blocks that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.4.1.3.1**). All of the assumptions (including the 6 other potential mitigating measures) and estimates are the same as for a proposed action (Alternative A). A description of Alternative A is presented in **Chapter 2.4.1.1**.

The Federal offshore area is divided into subareas based on water depths in meters (C0-60, C60-200, C200-400, C400-800, C800-1600, C1600-2400, and C>2400), and the adjacent coastal region is divided into five EIA's (LA-1, LA-2, LA-3, MS-1, and AL-1). These subareas and EIA's are delineated on **Figures 4-1 and 3-12**, respectively.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the CPA (Alternative A). The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. These are estimates only and not predictions of what will happen as a result of holding a proposed sale. A detailed discussion of the scenario and related impact-producing factors is presented in **Chapter 4.1**.

The analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts under Alternative B are expected to be the same as those under a typical proposed action in the CPA (**Chapter 4.2.2**) for the following resources:

–Air Quality
–Water Quality
–Sensitive Coastal Environments
–Live Bottoms (Pinnacle Trend)
–Continental Slope and Deepwater Benthic Communities
–Marine Mammals
–Sea Turtles
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Fish Resources and Essential Fish Habitat
–Commercial Fishing
–Recreational Fishing
–Recreational Resources
–Archaeological Resources
–Human Resources and Land Use

The impacts to some GOM resources under Alternative B would be different from the impacts expected under a proposed action. These impacts are described below.

Impacts on Sensitive Offshore Resources

Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for a proposed action. The potential impact-producing factors to the topographic features of the Central Gulf are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors is presented in **Chapter 4.2.2.1.4.1.2**.

Of the 16 topographic features of the CPA, 15 are located within water depths less than 200 m (656 ft). Geyer Bank is located in water depths of 190-210 m (623-689 ft). These features occupy a very small portion of the entire area. Of the potential impact-producing factors that may affect the topographic features, anchoring, structure emplacement, and structure removal will be eliminated by the adoption of this alternative. Effluent discharge and blowouts will not be a threat to the topographic features because blocks near enough to the banks for these events to have an impact on the biota of the banks will have been excluded from leasing under this alternative. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill. The potential impacts from oil spills are summarized below and are discussed further in **Chapter 4.4.4.1.2**.

A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. There is a 30-37 percent chance that one pipeline spill ≥1,000 bbl would occur, a 20-27 percent chance that a second pipeline spill ≥1,000 bbl would occur, and a 7-16 percent chance that a third pipeline spill ≥1,000 bbl would occur as a result of a CPA proposed action. The chance of a substantial amount of oil being released during a LOWC is 3 percent; however, no LOWC's are estimated to occur in <200 m (656 ft) as a result of a CPA proposed action. A subsurface spill is expected to rise to the surface, and any oil remaining at depth will be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Deepwater subsurface spills may travel along the sea bottom or in the water column for some distance before rising to the surface. The fact that the topographic features are widely dispersed in the Central Gulf, combined with the random nature of spill events, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. **Chapter 4.3.1.8** discussed the risk of spills interacting with topographic features, especially the Flower Garden Banks, in more detail. The currents that move around the banks will likely steer any spilled oil around the banks rather than directly upon them, lessening impact severity. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary) (CSA, 1992b and 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill contacted a coral-covered area (in the case of the Flower Garden Banks), the areal extent of coral mortality would be limited, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature, diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Conclusion

Alternative B is expected to cause little or no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill contacts the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Some lethal effects would probably occur upon oil contact to coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary); recovery from such an event is anticipated to occur within a period of 2 years.

4.2.2.3. Alternative C — The Proposed Action Excluding Unleased Blocks within 15 Miles of the Baldwin County, Alabama, Coast

Description of the Alternative

Alternative C differs from Alternative A (a proposed action) by not offering any unleased blocks within 15 mi of the Baldwin County, Alabama, coast. All the assumptions (including potential mitigating measures) and estimates are the same those under Alternative A (**Chapters 2.4.1.3 and 4.1.1**). A description of Alternative A is presented in **Chapter 2.4.1.1**.

The Federal offshore area is divided into subareas based on water depths in meters (C0-60, C60-200, C200-400, C400-800, C800-1600, C1600-2400, and C>2400). The coastal region adjacent to the area considered under Alternative C is EIA AL-1. These subareas are delineated on **Figure 2-1**.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the CPA (Alternative A). A detailed discussion of the scenario and related impact-producing factors is present in **Chapter 4.1**.

The analyses of impacts to the various resources under Alternative C are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their effects on the various resources. Impacts are expected to be the same as those estimated under a typical proposed action in the CPA (**Chapter 4.2.2**) for the following resources:

–Air Quality
–Sensitive Coastal Environments
–Live Bottoms (Pinnacle Trend)
–Topographic Features
–Continental Slope and Deepwater Benthic Communities
–Marine Mammals
–Sea Turtles
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Fish Resources and Essential Fish Habitat
–Commercial Fishing
–Recreational Fishing
–Human Resources and Land Use

Impacts to some GOM resources would be different from the impacts of a proposed action. These impacts are described below.

Impacts on Water Quality

Bottom-area disturbance resulting from platform emplacement and removal, drilling activities, and blowouts results in some level of increased water-column turbidity in overlying offshore waters. Generally, each of these operations has been shown to produce localized, temporary impacts on water quality conditions in the immediate vicinity of the emplacement operation (**Chapter 4.1.1.3.2**). Alternative C would eliminate impacts associated with platform emplacement in the areas within 15 mi off the coast of Baldwin County, Alabama.

The oil-spill events related to a proposed action under Alternative A were projected to be mostly very small events, to be very infrequent for spills greater than 50 bbl, to have effects for only a short-duration (from a few days to three months), and to affect only a small area of offshore waters at any one time (**Chapter 4.3.1**). These events would not be eliminated as a result of Alternative C. The risk of spills due to exploration and development would be eliminated within the deferral area.

Conclusion

Bottom disturbances from platform emplacements and removals, drilling activities, and blowouts would not occur within the excluded area under Alternative C. Localized, temporary impacts to water quality due to sediment resuspension would be eliminated in the area within 15 miles of the Baldwin County coast, if Alternative C is adopted. Additionally, the risk of oil-spill impacts would be slightly reduced as exploration and development operations would not occur in the excluded area.

Impacts on Archaeological Resources

As a result of a typical proposed action in the CPA, Federal waters offshore Alabama were assumed to have new exploration, delineation, and development wells drilled. There would be platform installations and pipelines laid in the area. The location of any proposed activity within a lease block that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. The probability of an OCS activity contacting and damaging a shipwreck is low; the required clearance measures are considered to be 90 percent effective at protecting potential unknown historic shipwrecks. If an OCS structure did contact a historic resource, unique archaeological information contained within a site or resource could be lost. Under Alternative C, drilling activities and installation of platforms within 15 mi of the shoreline of Baldwin County, Alabama, would not occur. Any potential impacts from drilling activities or platform emplacement to historic shipwrecks would be eliminated in OCS blocks within 15 mi of the Baldwin County shoreline.

Conclusion

The probability of an OCS activity contacting and damaging a shipwreck is low because of existing mitigation in the form of archaeological clearance requirements for proposed activities. Alternative C would eliminate the potential for impacts from drilling or platform emplacement to historic archaeological resources within the area excluded under Alternative C.

Impacts on Recreational Resources

The major impact-producing factors that could potentially affect recreational beaches include the presence of offshore structures, pipelaying activities, support helicopter and vessel traffic, trash and debris, and oil spills. Exploratory rig activity and platforms associated with OCS development activity could be viewed from coastal communities along the GOM when they are closer than approximately 10 mi from shore; beyond that, structures appear very small and barely discernable to the naked eye, eventually disappearing from view. Alternative C would exclude those blocks within 15 mi of the shoreline from leasing. No OCS structures would be constructed within the excluded area. Any visual impact due to OCS structures in the area off Baldwin County, Alabama, would be eliminated. Pipelaying activities, support helicopter and vessel traffic, trash and debris, and oil spills from the remaining areas offered from lease would continue to present potential impacts to recreational beaches.

Conclusion

Alternative C would exclude blocks within 15 mi of the Baldwin County, Alabama, coast from leasing. No OCS structures would be constructed within the excluded area. Therefore, any visual impact due to OCS structures in the area off Baldwin County would be eliminated.

4.2.2.4. Alternative D — Use of a Nomination and Tract Selection Leasing System

Description of the Alternative

This alternative would offer for lease for each proposed action a maximum of 1,000 industry-nominated blocks, and it would offer all blocks that become available for leasing after the industry nomination deadline and before the FNOS is published for that proposed action. The same exclusions described under the proposed action(s) would apply. The number of tracts offered would be about 25 percent of the tracts estimated to be offered under an areawide leasing system (Alternative A), and it is estimated this alternative would result in a 25 percent reduction in the number of tracts leased per proposed action.

Effects of the Alternative

The analyses of impacts described in detail in **Chapter 4.2.2** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapters 4.1.1 and 4.1.2**.

Based on recent leasing patterns, it is assumed the offered tracts would be evenly distributed throughout the 58.7-million-ac CPA sale area. Under nomination and tract selection leasing, it is assumed the best tracts would be made available and leased; therefore, the success rate of the leased tracts would be higher than success rate under areawide leasing. Although the number of resulting leases would be reduced, the estimated amount of resources under Alternative D would still fall within the range projected to be developed as a result of any one proposed CPA lease sale (0.776-1.292 BBO and 3.236-5.229 Tcf of gas) under Alternative A (**Chapter 4.1**). Therefore, the impacts to environmental and socioeconomic resources under Alternative D are expected to be the same as those estimated under a typical proposed action in the CPA (**Chapter 4.2.2**) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
–Live Bottoms (Pinnacle Trend and Topographic Features)
–Deepwater Benthic Communities
–Air Quality
–Marine Mammals
–Sea Turtles
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Commercial Fisheries
–Socioeconomic Conditions

Summary and Conclusion

The assumption that the levels and location of activity for Alternative D are the essentially the same as those projected for the proposed actions for Alternative A leads to the conclusion that the impacts expected to result from Alternative D would be very similar to those described under the proposed actions (**Chapters 4.2.2 and 4.4**). Therefore, the regional impact levels for all resources would be similar to those described under the proposed actions.

4.2.2.5. Alternative E — No Action

Description of the Alternative

Alternative E is equivalent to cancellation of a lease sale scheduled for a specific period in the *Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012.* By canceling a proposed lease sale, the opportunity is postponed or foregone for development of the estimated 0.776-1.292 BBO and 3.236-5.229 Tcf of gas. Any potential environmental and socioeconomic impacts resulting from a proposed sale (**Chapter 4.2.2**, Alternative A — The Proposed Actions) would be postponed or not occur.

Effects of the Alternative

Under Alternative E, USDOI cancels a planned CPA lease sale. Therefore, the discovery and development of oil and gas expected from a lease sale would be delayed or would not occur. The environmental and socioeconomic effects of Alternative A (proposed action) also would be delayed or not occur. Other sources of energy may substitute for the delayed or lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have their own significant negative environmental and socioeconomic impacts.

This section briefly discusses the most likely alternative energy sources, the quantities expected to be needed, and the environmental and socioeconomic impacts associated with these alternative energy sources. The discussion is based on material from the following MMS publications: *Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (USDOI, MMS, 2006l); *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012, Draft Environmental Impact Statement* (USDOI, MMS, 2006m); and *Energy Alternatives and the Environment* (USDOI, MMS, 2001e). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost Through No Lease Sale

Energy Alternatives and the Environment (USDOI, MMS, 2001e) discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from the lease sale would come from four sources:

- additional imports;
- conservation;
- additional domestic production; and
- fuel switching.

Additional domestic production and imports would augment supply, while conservation and switching to alternative fuels shift demand downward. The table below shows the percentage and range of quantities expected to be needed to substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	Percent of Lost Oil Production	Range of Oil Quantity (MMbbl)	Percent of Lost Gas Production	Range of Gas Quantity (Bcf)
Imports	86-88%	667-1,137	16%	518-837
Conservation	6-7%	47-90	16-17%	518-889
Additional Domestic Production	3%	23-39	26-28%	841-1,464
Fuel Switching	4-5%	31-65	40-42%	1,294-2,196
Total Production Lost through No Sale	100%	776-1,292	100%	3,236-5,229

Notes: Bcf = billion cubic feet.
MMbbl = million barrels.

Environmental and Socioeconomic Impacts from the Most Likely Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);
- degradation of water quality from oil spills related to accidental discharges or tanker casualties;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas; and
- increasing public concern about tanker spills.

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources—Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation); and
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter).

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology would tend to result in positive net gains to the environment. The amount of gain would depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation.

Fuel Switching: The most likely substitutes for natural gas are oil, which would further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own negative environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* (USDOI, MMS, 2001e) discusses many of the alternatives at a level of detail impossible here.

Summary and Conclusion

Canceling a lease sale would eliminate the effects described for Alternative A (**Chapter 4.2.2**). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant negative environmental impacts of their own.

4.3. Impact-Producing Factors and Scenario—Accidental Events

The National Environmental Policy Act (NEPA) requires Federal agencies to consider potential environmental impacts of proposed actions as part of agency planning and decisionmaking. Through the NEPA process actions that could result in impacts, including those impacts that have a very low probability of occurrence, but that the public considers important, are controversial, or may have severe consequences are analyzed. The accidental events that fall into this category and are addressed in this section are oil spills, losses of well control, vessel collisions, and spills of chemicals or drilling fluids.

4.3.1. Oil Spills

Large oil spills associated with OCS activities are low-probability events. Public input through scoping meetings and Federal and State agencies' input through consultation and coordination indicate that oil spills continue to be a major issue. This section analyzes the risk of spills that could occur as a result of typical proposed actions in the WPA and CPA. **Chapter 4.1.3.4** provides information on accidental spills that could result from all operations conducted under the OCS Program, as well as information on the number and sizes of spills from non-OCS sources.

4.3.1.1. Spill Prevention

Beginning in the 1980's, MMS established comprehensive pollution prevention requirements that include redundant safety systems, as well as inspection and testing requirements to confirm that these devices are working properly (**Chapter 1.5).** An overall reduction in spill volume has occurred over the past 40 years while oil production has generally increased. The MMS attributes this improvement to MMS operational requirements, ongoing efforts by the oil and gas industry to enhance safety and pollution prevention, and the evolution and improvement of offshore technology.

Part of those safety systems are subsurface safety valves (SSSV) and downhole safety valves (DSV). Should a platform be damaged, these valves "shut-in" production flow to prevent pollution events until the production can be safely reestablished. During Hurricanes Ivan, Katrina and Rita, these valves performed successfully (U.S. Senate, Committee on Energy and Natural Resources, 2005; USDOI, MMS, 2005).

4.3.1.2. Overview of Spill Risk Analysis

There are many factors that MMS evaluates to determine the risk of impact occurring from an oil spill. Estimated information includes likely spill sources, likely spill locations, likely spill sizes, the likelihood and frequency of occurrence for different size spills, timeframes for the persistence of spilled oil, volumes of oil removed due to weathering and cleanup, and the likelihood of transport by wind and waves resulting in contact to specified environmental features. This section of the EIS addresses the likelihood of spill occurrence, transportation of oil slicks by winds and waves, and the probability of an oil spill contacting sensitive environmental resources. Sensitivity of the environmental resources and potential effects are addressed in the analyses for the specific resources of concern (**Chapter 4.4**).

The MMS uses data on past OCS production and spills, along with estimates of future production, to evaluate the risk of future spills. Data on the numbers, types, sizes, and other information on past spills were reviewed to develop the spill scenario for analysis in this EIS. The spill scenario provides the set of assumptions and estimates of future spills; the type, frequency, quantity, and fate of the spilled oil for specific scenarios; and the rationale for the scenario assumptions or estimates. The spill scenario accounts for spill response and cleanup activities and the estimated time that the spill remains floating on the water.

The MMS uses two numerical models to calculate the likely trajectory and weathering of spills and analyzes the historical database to make other oil-spill projections. Estimates are based on historical spills and do not consider the effect of the recent retirement of older platforms and pipelines in preventing spills. A description of the trajectory model, called the OSRA (oil spill risk analysis) model, and its results are summarized in this EIS and are published in a separate report (Ji et al., in preparation). The OSRA model simulates thousands of spills launched throughout the GOM OCS and calculates the probability of these spills being transported and contacting specified environmental resources. The OSRA modeling results in a numerical expression of risk based on spill rates, projected oil production, and trajectory modeling. Version III of the oil-weathering model used by MMS was released in June 2004 (Reed et al., 2005).

The following discussion provides separate risk information for offshore spills ≥1,000 bbl, offshore spills <1,000 bbl, and coastal spills that may result from the proposed actions.

4.3.1.3. Past OCS Spills

4.3.1.3.1. Offshore Spills

The MMS spill-event database includes records of past spills from activities that MMS regulates. These data include oil spills >1 bbl that occurred in Federal waters from OCS facilities and pipeline operations. Spills from facilities include spills from drilling rigs, drillships, and storage, processing, or production platforms that occurred during OCS drilling, development, and production operations. Spills from pipeline operations are those that have occurred on the OCS and are directly attributable to the transportation of OCS oil.

The most recent, published analysis of trends in OCS spills 1985-1999 was used to project future spill risk for this EIS (Anderson and LaBelle, 2000). Data for this period reflect recent spill prevention and occurrence conditions. The 15-year record was chosen because it reflects how the spill rates have changed while still maintaining a significant portion of the record.

Chapter 4.1.3.4.4.2, Spills as the Result of Hurricanes, discusses the cause and volume of spills that resulted from the recent hurricanes. The first compilation of spills from Hurricanes Katrina and Rita in 2005 became available in early August 2006. Using this very preliminary data and employing the same methodology as in Anderson and LaBelle (2000), MMS calculated spill rates based on the 1991-2005 15-year dataset. This dataset includes a pipeline spill from Hurricane Katrina, and both a platform and a pipeline spill from Hurricane Rita. The spill rate methodology treats each hurricane as an "event," so that if there is more than one spill of ≥1,000 bbl during a hurricane, all spills are counted as one event of the size of the sum of those volumes. Using this methodology, the two pipeline spills of 1,812 and 1,551 bbl during Hurricane Rita become one pipeline spill of 3,363 bbl, and the three platform spills of 2,000, 1,494, and 1,572 bbl during Hurricane Rita become one platform spill of 5,066 bbl. The calculations show the pipeline spill occurrence rate for spills ≥1,000 bbl based on 1991-2005 data would decline to 1.26 spills per BBO handled as compared with 1.38 spills per BBO handled based on the 1985-1999 data. The platform spill occurrence rate for spills ≥1,000 bbl would increase to 0.14 spills per BBO handled as compared to less than 0.13 spills per billion bbl handled based on the 1985-1999 data (Anderson, personal communication, 2006).

Of the six hurricane-related spills of ≥1,000 bbl currently identified, three are based on "worst case estimates" and may be reduced below the 1,000 bbl threshold as more information becomes available. The estimation of the spillage associated with these hurricanes will not be complete until all operators have completed recovery efforts associated with the repair and/or have completed decommissioning of all the damaged structures. Some of the petroleum currently counted as spilled may yet be recovered from intact tanks, and additional damages may yet be discovered by the operators. These repair, recovery, and decommissioning activities will continue through 2006 and possibly into 2007. In addition to spills, the numerator of the OCS spill occurrence rates, one must consider the volume of oil handled, the denominator of the spill rates. From 1985 to around 1995, OCS production was on the order of a third of a BBO per year. Since around 1995, OCS production has been more on the order of half a BBO or more. The pipeline spill rate has been pretty consistent over time. Platform spill(s) ≥1,000 bbl from Hurricanes Katrina and Rita is the first since 1980, which is a huge amount of production between spills. Therefore, MMS feels that the 1985-1999 spill rates, which are used for this EIS, are appropriate.

Table 4-16 presents oil spills for seven different spill-size groupings for the period 1985-1999. Data are provided on the total number of spills, number of spills by operation, total volume of oil spilled, and the spill rate calculated from data on historical spills and production. The average spill size and median spill size during this period are given for each spill-size category.

Tables 4-33 and 4-34 provide information on OCS oil and chemical spills ≥1,000 bbl that have occurred offshore in the GOM for the entire period that records have been kept (1964-present). These data are divided into two groups based on whether the spills were from accidents associated with facility operations or pipeline transportation. The data show that there were no facility spills ≥1,000 bbl of crude oil, although seven spills of SBF, diesel, or chemicals did occur. Eight of the 14 pipeline spills ≥1,000 bbl during the period 1985-present were crude oil spills. Pipeline spills result from damage caused by anchors, fishing trawls, mudslides, and hurricanes. Some of the spill volumes are estimates. The estimated total spillage associated with the 2004 and 2005 hurricanes will not be finalized until all the operators have completed recovery efforts associated with the repair and/or decommissioning of all the damaged structures is completed. The actual release volume will be updated in the future.

The MMS data records do not include spills ≤1 bbl, but data on these small spills are available from the USCG Marine Safety Information System. Also not included in the MMS database are spills that have occurred in Federal waters from OCS barging operations and from other service vessels that support the OCS oil and gas industry. These data are included in the USCG record of all spills; however, the USCG database does not include the source of oil (OCS versus non-OCS) or in the case of spills from vessels, the type of vessel operations; such information is needed to determine if a particular spill occurred as a result of OCS operations.

4.3.1.3.2. Coastal Spills

Spills have occurred in coastal waters at shoreline storage, processing, or transport facilities supporting the OCS oil and gas industry. Coastal spills have occurred in State offshore waters and in navigation channels, rivers, and bays from barges and pipelines carrying OCS-produced oil. Records of spills in coastal waters and State offshore waters are maintained by the USCG (USDOT, Coast Guard, 2001), but the database does not identify the source of the oil (OCS versus non-OCS). A pipeline carrying oil from a shore base to a refinery may be carrying oil stored from both State and OCS production; imported oil might also be commingled in the pipeline. The MMS does not maintain records on coastal spill events. Therefore, there is no database available that contains all past spills that have occurred in State offshore or coastal waters directly as a result of OCS oil and gas development. Information on past coastal spills that have occurred in the GOM area is found in **Chapter 4.1.3.4**.

4.3.1.4. Characteristics of OCS Oil

The physical and chemical properties of oil greatly affect how it will behave on the water surface (surface spills) or in the water column (subsea spills), the persistence of the slick on the water, the type and speed of weathering process, the degree and mechanisms of toxicity, the effectiveness of containment and recovery equipment, and the ultimate fate of the spill residues. Crude oils are a mixture of hundreds of different compounds. Hydrocarbons account for up to 98 percent of the total composition. The chemical composition of crude oil can vary significantly from different producing areas; thus, the exact composition of oil being produced in OCS waters varies throughout the Gulf.

The API gravity is a measurement of the density of the oil. The API gravity is calculated from the specific gravity; the lower the specific gravity, the higher the API gravity and the lighter the oil will be. Density is one of the most important physical characteristics of crude oil. The density of oil determines whether it will sink or float, or whether it will collect sediment (heavier oils tend to collect sediment) and sink. The density of oil is one of the key factors in predicting whether spilled oil will entrain water and form emulsions.

There are 26 oils identified in the GOM (Environment Canada, 2006). The API gravities of 91 plays are identified in the MMS 1995 National Assessment (Lore et al., 1999). The MMS data atlas presents an average of the many reservoirs contained in each play. In an MMS study that analyzed the API gravities (Trudel et al., 2001) of these 67 plays, the range of the API gravities was 22.8°-58.6°. It is expected that a typical oil spilled as a result of an accident associated with a proposed action would be within the range of 30°-35° API. The oil at the light end of the range would have little asphaltenes, would not emulsify, and would not form tarballs. The oil at the heavier end of the range would more likely emulsify and form tarballs.

4.3.1.5. Risk Analysis for Offshore Spills ≥1,000 bbl

This section addresses the risk of spills ≥1,000 bbl that could occur from accidents associated with activities resulting from a proposed action.

4.3.1.5.1. Estimated Number of Offshore Spills ≥1,000 bbl and Probability of Occurrence

The number of spills ≥1,000 bbl estimated to occur as a result of a proposed action is provided in **Table 4-35**. The mean number of spills estimated for a proposed action in the WPA is less than one spill (mean equal to 0.37-0.62). The mean number of spills estimated for a proposed action in the CPA is 1-2 spills (mean equal to 1.2-2.0). The range of the mean number of spills reflects the range of oil production volume estimated as a result of a proposed action. The mean number of future spills ≥1,000 bbl is calculated by multiplying the spill rate for spills ≥1,000 bbl (1.51) by the volume of oil estimated to be produced as a result of a proposed action.

Figures 4-11 and 4-12 provide the probability of a particular number of offshore spills ≥1,000 bbl resulting from a proposed action during the 40-year analysis period.

For a proposed action in the CPA, there is a 28-36 percent chance of one spill ≥1,000 bbl occurring, a 21-27 percent chance of two spills ≥1,000 bbl occurring, a 8-18 percent chance of three spills ≥1,000 bbl occurring, a 2-9 percent chance of four spills ≥1,000 bbl occurring, a 1-3 percent chance of five spills ≥1,000 bbl occurring, and a 0-1 percent chance of six spills ≥1,000 bbl occurring. Overall, there is a 69-86 percent chance of one or more spills ≥1,000 bbl occurring.

For a proposed action in the WPA, there is a 25-33 percent chance of one spill ≥1,000 bbl occurring, a 5-10 percent chance of two spills ≥1,000 bbl occurring, and a 1-2 percent chance of three spills ≥1,000 bbl occurring. Overall, there is a 31-46 percent chance of one or more spills ≥1,000 bbl occurring.

Spill rates for all of the spill-size categories are provided in **Table 4-16**. Spill rates were calculated based on the assumption that spills occur in direct proportion to the volume of oil handled and are expressed as number of spills per billion barrels of oil handled.

A published paper by MMS authors provides more information on OCS spill-rate methodologies and trends (Anderson and LaBelle, 2000). A discussion of how the range of resource estimates was developed is provided in **Chapter 4.1.1.1**.

4.3.1.5.2. Most Likely Source of Offshore Spills ≥1,000 bbl

Figures 4-11 and 4-12 indicate the probabilities of one or more spills ≥1,000 bbl occurring from an OCS facility or pipeline operations related to a proposed action. The data used in **Table 4-16** (1985-1999) show that the most likely cause of a spill ≥1,000 bbl is a pipeline break at the seafloor. The hurricanes of 2004 and 2005 resulted in eight spills ≥1,000 bbl, including two crude spills, three condensate spills, two refined oil spills, and one chemical (methanol) spill.

4.3.1.5.3. Most Likely Size of an Offshore Spill ≥1,000 bbl

The median size of spills ≥1,000 bbl that occurred during 1985-1999 is 4,551 bbl and the median size for spills ≥10,000 bbl is 15,000 bbl (**Table 4-16**). Based on these median sizes, MMS estimates that the most likely size of a spill ≥1,000 bbl from a proposed action would be 4,600 bbl.

4.3.1.5.4. Fate of Offshore Spills ≥1,000 bbl

Persistence

The persistence of an offshore oil slick is strongly influenced by how rapidly it spreads and weathers and by the effectiveness of oil-spill response in removing the oil from the water surface.

As part of the risk analysis of an offshore spill ≥1,000 bbl, MMS estimated the expected persistence time of the spill, specifically, how long it might last as a cohesive mass on the surface of the water, capable of being tracked and moved by winds and currents. **Tables 4-36 and 4-37** provide a mass balance over time for a likely spill related to a proposed action in each planning area. The MMS estimates that a spill ≥1,000 bbl with the characteristics and parameters specified in the table below would dissipate from the water surface in 2-10 days.

Spreading

The GOM oils having API gravities between 30^{o} and 35^{o} will float, except under turbulent mixing conditions such as during a large storm offshore. Once spilled, it is expected that all GOM oils would rise and reach the surface of the open Gulf. On the sea surface, the oil would rapidly spread out on the water surface, forming a slick that is initially a few millimeters (mm) in thickness in the center and much thinner around the edges. The rate of spreading depends upon the viscosity of the spilled oil, whether or not the oil is released at the water surface or subsurface, and whether the spill is instantaneous or continuous for some period. The spilled oil would continue to spread until its thickest part is about 0.1 mm. Once it spreads thinner than 0.1 mm, the slick would begin to break up into small patches, forming a number of elongated slicks, with an even thinner sheen trailing behind each patch of oil.

Tables 4-36 and 4-37 provides an estimate of the thickness and areal extent of a typical oil slick for different times after a spill event. If an offshore spill ≥1,000 bbl of oil having the properties and characteristics specified in the table below were to occur as a result of a proposed action and typical cleanup response was to take place, the slick would attain its greatest surface area by 12 hours after the spill event. The maximum water surface area covered by such a slick would be between 200 and 350 ac.

Weathering

Immediately upon being spilled, oil begins reacting with the environment. This process is called weathering. A number of processes alter the chemical and physical characteristics of the original hydrocarbon mixture, which reduces the oil mass over time. Weathering processes include evaporation of volatile hydrocarbons into the atmosphere, dissolution of soluble components, dispersion of oil droplets into the water column, emulsification and spreading of the slick on the surface of the water, chemo- or photo-oxidation of specific compounds creating new components that are often more soluble, and biodegradation. Weathering and the existing meteorological and oceanographic conditions determine the time that the oil remains on the surface of the water, and the characteristics of the oil at the time of contact with a particular resource also influence the persistence time of an oil slick. Oil-spill cleanup timing and effectiveness would also be determining factors.

Chemical, physical, and biological processes operate on spilled oil to change its hydrocarbon compounds, reducing many of the components until the slick can no longer continue as a cohesive mass floating on the surface of the water. By spreading out, the oil's more volatile components are exposed to the atmosphere and up to about two-thirds of the oil evaporates rapidly.

Over time, if the slick is not completely dissipated, a tar-like residue may be left; this residue breaks up into smaller tar lumps or tarballs that usually sink below the sea surface but not necessarily to the seafloor. Not all oils form tarballs; many GOM oils do not (Jefferies, 1979).

The MMS uses the SINTEF model to numerically model weathering processes to (1) estimate the likely amount of oil remaining on the ocean surface as a function of time and (2) predict the composition of any remaining oil. **Tables 4-36 and 4-37** summarize the model's results for a typical oil and the environmental scenarios in the WPA and CPA.

Four scenarios were modeled. Information on the SINTEF model can be found in Daling et al. (1997), Reed et al. (2000), and Prentki et al. (2004). The table below provides the scenario parameters used for the weathering model runs.

Input Parameters Used to Run Four Scenarios for Weathering Model

Parameter	Input
Spill Size	4,600 bbl
Duration of Spill	24 hours
API Gravity of Spilled 0il	Two oils: (1) 30^{o} API (Garden Banks) and (2) 35^{o} API (Grand Isle)
Surface Water Temperature	Summer WPA & CPA 29 ^{o}C Winter WPA & CPA 20.2 ^{o}C
Mean Wind Speed	Summer WPA 5.3 m/s Winter WPA 7.2 m/s Summer CPA 4.0 m/s Winter CPA 7.2 m/s
Distance of Spill Source from Shore	200 mi
Emulsification Formation	Yes for 30 ^{o} API oil No for 35 ^{o} API oil

The results of the weathering analyses are summarized in **Tables 4-36 and 4-37**. By 10 days after a spill event of ≥1,000 bbl, approximately 32-74 percent of the slick would have dissipated by natural weathering, between 30 and 32 percent would have been lost to the atmosphere via evaporation, and about 2-42 percent would have been lost into the water column via natural dispersion. The volume of the slick would be further reduced by spill-response efforts (**Chapter 4.3.5**).

Seafloor Release

All evidence to date indicates that accidental oil discharges that occur at the seafloor (for example, from a loss of well control or a pipeline break) would rise in the water column, surfacing almost directly over the source location. All known reserves in the Gulf to date have specific gravities and chemical characteristics that would preclude oil slicks from sinking. Evidence from direct observation and remote imagery from space indicates oil slicks originating from natural seeps in the GOM occur on the sea surface almost directly above the known seep locations. It is estimated that 980,000 bbl of oil is released to the GOM annually from natural seeps (NRC, 2003). Shipboard observations during submersible operations noted the surface expression of rising oil at a horizontal distance of 100 m (328 ft) from the origin of the seep on the bottom (MacDonald et al., 1995). A study in Norway, which intentionally released oil with chemical characteristics similar to GOM OCS oils at depth (844 m) and simulated blowout conditions, provided direct evidence that such an oil spill quickly rises to the surface. Within an hour after release, the oil appeared on the surface within a few hundred meters (horizontally) of the release site (Johansen et al., 2001).

4.3.1.5.5. Transport of Spills ≥1,000 bbl by Winds and Currents

Using the OSRA model, MMS estimates the likely trajectories of hypothetical offshore spills ≥1,000 bbl. The trajectories combined with estimated spill occurrence are used to estimate the risk of future spills occurring and contacting environmental features.

The OSRA model simulates the trajectory of a point launched from locations mapped onto a gridded area. The gridded area represents an area of the GOM, and the point's trajectory simulates a spill's movement on the surface of water using modeled ocean current and wind fields. The model uses temporally and spatially varying, numerically computed ocean currents and winds.

The OSRA model can simulate a large number of hypothetical trajectories from each launch point. Spill trajectories are launched once per day from each origin point and are time stepped every hour until a statistically valid number of simulations have been run to characterize the risk of contact. The simulated oil spills for this EIS were “launched” from approximately 4,000 points uniformly distributed 6-7 mi apart within the Gulf OCS. This spacing between launch points is sufficient to provide a resolution that created a statistically valid characterization of the entire area (Price et al., 2001).

The model tabulates the number of times that each trajectory moves across or touches a location (contact) occupied by polygons mapped on the gridded area. These polygons represent locations of various environmental features. The OSRA model compiles the number of contacts to each environmental feature that result from all of the modeled trajectory simulations from all of the launch points for a specific area. Contact occurs for offshore features if the trajectory simulation passes through the polygon. Contact occurs for land-based features if the trajectory simulation touches the border of the feature. The simulation stops when the trajectory contacts the lines representing the land/water boundary or the borders of the domain. The probability of contact to an environmental feature is calculated by dividing the number of contacts by the number of trajectories started at various launch locations in the gridded area.

The output from this component of the OSRA model provides information on the likely trajectory of a spill by wind and current transport, should one occur and persist for the time modeled in the simulations; the calculations for this EIS were modeled for 10 days. Because the analysis of the fate of a likely OCS spill (**Chapter 4.3.1.6.4**) showed that a slick would not persist on the water surface beyond 10 days, the OSRA model simulations were analyzed up to 10 days. All contacts that occurred during this period were tabulated.

A detailed description of the OSRA model used in this analysis is provided separately in a published report (Ji et al., in preparation). This report, including its figures and tables, will be available from the MMS Internet site (http://www.mms.gov).

4.3.1.5.6. Length of Coastline Affected by Offshore Spills ≥1,000 bbl

Tables 4-36 and 4-37 provides MMS’s estimates of the length of shoreline that could be contacted if a typical spill ≥1,000 bbl occurred as a result of an accident associated with a proposed action. The length of shoreline contacted is dependent upon the original spill size and the volume of oil removed by natural weathering and offshore cleanup operations prior to the slick making shoreline contact. The shoreline length contacted is a simple arithmetic calculation based on the area of the remaining slick. The calculation assumes that the slick will be carried 30 m (98 ft) inshore of the shoreline, either onto the beachfront up from the water’s edge or into the bays and estuaries, and will be spread out at uniform thickness of 1 mm; this assumes that no oil-spill boom is used. The maximum length of shoreline affected by a typical spill ≥1,000 bbl is estimated to be 30-50 km (19-31 mi) of shoreline, assuming such a spill were to reach land within 12 hours. Some redistribution of the oil due to longshore currents and further smearing of the slick from its original landfall could also occur.

4.3.1.5.7. Likelihood of an Offshore Spill ≥1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

A more complete measure of spill risk was calculated by multiplying the probability of contact generated by the OSRA model by the probability of occurrence of one or more spills ≥1,000 bbl as a result of a proposed action. This provides a risk factor that represents the probability of a spill occurring as a result of a proposed action and contacting the resource of concern. These numbers are often referred to as “combined probabilities” because they combine the risk of occurrence of a spill from OCS sources and the risk of such a spill contacting sensitive environmental resources.

The combined probabilities are provided for each resource of concern in **Figures 4-13 through 4-31**. A discussion of spill risk to the resources is provided in **Chapter 4.3.1.8**.

To better reflect the geologic distribution of oil and gas resources and natural variances of meteorological and oceanographic conditions in the computation of combined probabilities, the MMS also generated combined probabilities for smaller areas within the WPA and CPA. The MMS used a cluster analysis to analyze the contact probabilities generated for each of the 4,000 launch points. For this analysis, similar trajectories and contact to 10-mi (16 km) shoreline segments were used to identify offshore cluster areas. The estimated oil production from a proposed action was proportionally distributed to the cluster areas and the likelihood of spill occurrence was calculated for each cluster area. The probability of spill occurrence was combined with probabilities of contact from the trajectory modeling to estimate the combined risk of spills occurring and contacting various resources from spills in each cluster area. To account for the risk of spills occurring from the transportation of oil to shore, generalized pipeline corridors originating within each of the offshore cluster areas and terminating at major oil pipeline landfall areas were developed. The oil volume estimated to be produced as a result of a proposed action within each cluster area was proportioned among the pipeline corridors. The mean number of spills and the probability of contact of spills from each pipeline corridor were then calculated and combined with the risk of spills occurring and contacting resources from OCS facility development and production operations to complete the analysis.

4.3.1.6. Risk Analysis for Offshore Spills <1,000 bbl

The following section addresses the risk of spills <1,000 bbl resulting from a proposed action. To discuss spills <1,000 bbl, information is broken into size groups shown in **Table 4-16**.

Analysis of historical data shows that most offshore OCS oil spills have been ≤1 bbl (**Figure 4-32**). Although spills of ≤1 bbl have made up 94 percent of all OCS-related spill occurrences; spills of this size have contributed very little (5%) to the total volume of OCS oil that has been spilled. Most of the total volume of OCS oil spilled (95%) has been from spills ≥10 bbl.

4.3.1.6.1. Estimated Number of Offshore Spills <1,000 bbl and Total Volume of Oil Spilled

The number of spills <1,000 bbl estimated to occur over the next 40 years as a result of the proposed action is provided in **Table 4-35**. The number of spills is estimated by multiplying the oil-spill rate (**Table 4-16**) for each of the different spill size groups by the projected oil production as a result of a proposed action (**Table 4-1**). As spill size increases, the occurrence rate decreases and so the number of spills estimated to occur decreases.

The number of spills >500 and <1,000 bbl estimated to occur is less than one for a WPA proposed action. The number of spills >500 and <1,000 bbl estimated to occur is less than one to one for a CPA proposed action.

The chance of one spill between 500 and 1,000 bbl occurring is 11-17 percent for a WPA proposed action and 26-34 percent for a CPA proposed action.

In the spill size range of >50-500 bbl, 2-3 spills are estimated to occur from activities related to a WPA proposed action, and 5-8 spills are estimated to occur from activities related to a CPA proposed action.

Multiplying the estimated number of spills by the median or average spill sizes for each size group yields the volume of oil estimated to be spilled as a result of a proposed action over the 40-year analysis period. A total of 400-1,250 bbl of oil is estimated from spills <1,000 bbl as a result of a WPA proposed action. A total of 1,050-2,400 bbl of oil is estimated from spills <1,000 bbl as a result of a CPA proposed action.

4.3.1.6.2. Most Likely Source and Type of Offshore Spills <1,000 bbl

Most spills <1,000 bbl would likely occur from a mishap on a production facility, most likely related to a failure related to storage of oil. Analysis of the 24 offshore oil spills >50 and <1,000 bbl that occurred between 1985 and 1999 showed that 42 percent were diesel spills, 25 percent were condensate spills, and 21 percent were crude oil spills. The remaining spills were hydraulic fluids (2 spills) and diesel fuel or mineral oil-based drilling muds (2 spills). The most likely type of spill <1,000 bbl as a result of a proposed action is a diesel spill.

4.3.1.6.3. Most Likely Size of Offshore Spills <1,000 bbl

Table 4-35 provides the most likely volume of oil estimated to be spilled for each of the spill-size groups. The average spill size is used for spills with size <1 bbl. For the larger spill size ranges, the median spill size calculated for each category from MMS historical records is used (**Table 4-16**). During the 40-year analysis period, 97 percent of spills <1,000 bbl estimated to occur as a result of a proposed action would be ≤1 bbl.

4.3.1.6.4. Persistence, Spreading, and Weathering of Offshore Oil Spills <1,000 bbl

It is expected that slicks from spills <1,000 bbl will persist a few minutes (<1 bbl), a few hours (<10 bbl), or a few days (10-1,000 bbl) on the open ocean. Spilled oil would rapidly spread out, evaporate, and weather, quickly becoming dispersed into the water column. Most spills <1,000 bbl are expected to be diesel, which dissipates very rapidly. Diesel is a distillate of crude oil and does not contain the heavier components that contribute to crude oil's longer persistence in the environment.

4.3.1.6.5. Transport of Spills <1,000 bbl by Winds and Currents

To be transported by winds and currents, an oil slick must remain a drifting cohesive mass. Only spills >50 bbl have a chance of remaining a cohesive mass long enough to be transported any distance.

4.3.1.6.6. Likelihood of an Offshore Spill <1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

Because spills <1,000 bbl are not expected to persist as a slick on the surface of the water beyond a few days and because spills on the OCS would occur at least 3-10 nmi from shore, it is unlikely that any spills would make landfall prior to breaking up. For an offshore spill <1,000 bbl to make landfall, the spill would have to occur proximate to State waters (defined as 3-12 mi from shore). If a spill were to occur proximate to State waters, only a spill >50 bbl would be expected to have a chance of persisting long enough to reach land. Spills >50 and <1,000 bbl size are very infrequent. Should such a spill occur, the volume that would make landfall would be expected to be extremely small (a few barrels). These assumptions are supported by a previous analysis of 3-day trajectory model runs, previous weathering analyses, and historical records of spill incidents.

4.3.1.7. Risk Analysis for Coastal Spills

Spills in coastal waters could occur at storage or processing facilities supporting the OCS oil and gas industry or from the transportation of OCS-produced oil through State offshore waters and along navigation channels, rivers, and through coastal bays. The MMS projects that almost all (>99%) oil produced as a result of a proposed action will be brought ashore via pipelines to oil pipeline shore bases, stored at these facilities, and eventually transferred via pipeline or barge to Gulf coastal refineries. Because oil is commingled at shore bases and cannot be directly attributed to a particular lease sale, this analysis of coastal spills addresses spills that could occur prior to the oil arriving at the initial shoreline facility. It is also possible that non-OCS oil may be commingled with OCS oil at these facilities or during subsequent secondary transport.

4.3.1.7.1. Estimated Number and Most Likely Sizes of Coastal Spills

Several USCG resources were used to estimate the number of coastal oil spills attributable to a proposed action, including the USCG Polluting Incident Compendium and data obtained from the USCG. The number of GOM coastal spills from eight sources associated with State or Federal offshore production and international importation was determined from the data. The sources that were counted are fixed platforms, MODU, offshore marine facilities, OSV, offshore pipelines, tank barges, tank ships, and unknown sources. The number of spills of crude oil produced in Federal water was assumed to occur at the same proportion to the total number of spills as the volume of OCS produced oil, proportional with the total volume comprised of production on the OCS and in State waters and importation of crude oil.

Chapter 4.1.3.4 provides more information on oil spills from these other operations. The effect of the replacement of aged pipelines with new pipelines would be reflected in the spill data. The range was obtained by performing the calculation with national data and with GOM data.

In 2001, a total of 270 spills occurred in coastal GOM, of which roughly half were from the source types associated with State or Federal offshore oil production, oil importation, and unknown sources. All spills of unknown origin were counted as OCS in origin, which would not be the case in reality. Three billion barrels of total oil, including condensate, was transported to shore from Federal and State offshore production and importation. Federal OCS production comprised 19 percent of the oil transported to the coast and therefore is assumed to account for 19 percent of the spills. The amounts of various fuel oils transported for the purpose of consumption are not counted in this volume. Thus, the OCS production spill rate in coastal waters was determined to be in the range of 57-74 spills per BBO.

For a WPA proposed action, 0.242-0.423 Bbbl of oil production are projected to occur over a 34-year production period. Given an estimated spill rate of 57-74 spills per BBO, it is estimated that 15-34 spills of OCS oil will occur in the coastal area (**Table 4-38**). One spill >50 bbl but <1,000 bbl will occur and less than one to one spill ≥1,000 bbl will occur. The assumed spill size for the smallest spill size category, ≤1 bbl, is the mean spill size of recorded spills to the GOM recorded over a 14 year period spill. The assumed spill sizes for the next two, less frequent, spill size categories was determined by the median spill size of recorded spills to the GOM recorded over a 14-year period spill. A 3,000-bbl spill size is assumed for the ≥1,000-bbl spill.

For a CPA proposed action, 0.776-0.1.292 Bbbl of oil production is projected to occur over a 34-year production period. Given an estimated spill rate of 57-74 spills per BBO, it is estimated that 46-102 spills of OCS oil will occur in the coastal area (**Table 4-38**). Two to five spills >50 bbl but <1,000 and less than one to one spill ≥1,000 bbl is estimated. The assumed spill size within the three smallest spill size categories was determined by using the mean spill size for a spill ≤1 bbl and median spill size for larger, less frequently recorded spills to coastal GOM from 1986 to 2001.

4.3.1.7.2. Likelihood of Coastal Spill Contact with Various Resources

The coastal spill rate is based on historical spills and the projected amount of oil production. For the purpose of this analysis, coastal spills are assumed to occur where oil production is brought to shore. **Figure 4-33** shows major oil pipeline landfall areas.

Because the majority of oil production from a WPA proposed action is projected to be brought to shore in the Galveston/Houston/Texas City Area, it is assumed the majority of coastal spills from a WPA proposed action will also occur in this area. It is projected that the majority of oil production for a CPA proposed action will be brought to shore in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River. Based on this assumption the majority of coastal spills are projected to occur in this area, including one spill ≥1,000 bbl (assumed size 3,000 bbl) estimated to occur as the result of a CPA proposed action.

4.3.1.8. Risk Analysis by Resource

This section summarizes MMS's information on the risk to resources analyzed in this EIS from oil spills and oil slicks that could occur as a result of a proposed action in the WPA or CPA. The risk results are based on MMS's estimates of likely spill locations, sources, sizes, frequency of occurrence, physical fates of different types of oil slicks, and probable transport that are described in more detail in the preceding spill scenarios. For offshore spills, this analysis presents combined probabilities, which include both the likelihood of a spill from a proposed action occurring and the likelihood of the oil slick reaching areas where known environmental resources occur. The analysis of the likelihood of direct exposure and interaction of a resource with an oil slick and the sensitivity of a resource to the oil is provided under each resource category in **Chapter 4.4**. The coastal spill risk is estimated from historic rate, not a probability.

The term "oil spill" is a term that has several meanings. It may be used to describe the actual action of spilling oil. It is often used interchangeably with "oil slick." In this EIS, "oil spill" is used to describe an event that has a life history—it has a "birth" (the action of spilling) and is subjected to physical processes such as "aging" (weathering). Therefore, the oil spill can be described as undergoing life history stages, which include the following: slick formation, spreading, photolysis and evaporation, dissolution of water-soluble components, oil-in-water dispersion, adsorption to particles, microbiological degradation, vertical and horizontal diffusion, sedimentation, and resurfacing of larger oil droplets. Some of these stages are processes, while others describe the physical status of the spilled hydrocarbons.

Risk to sensitive environmental resources does not disappear when the "slick" disappears. After a slick disperses, hydrocarbons continue to persist in the sea for decades or longer. Marine organisms are exposed to these hydrocarbons in the waters where they reside, as well as through the prey that they consume. For example, FWS biologists from Texas recently commented to MMS that they are still finding tarballs, probably from the *Ixtoc* oil spill in Mexico that occurred decades ago, washing up on Padre Island National Seashore (PINS), a nesting beach for endangered Kemp's ridley sea turtles. Not far away is the Aransas National Wildlife Refuge, which is critical habitat to the endangered whooping crane. Sea turtle hatchlings that evacuate nests on PINS are at risk of ingesting or becoming fouled with these tarballs. Whooping cranes are also at risk of contact as they forage in estuarine and bay waters along the Coastal Bend region of Texas. During foraging forays, they may ingest or become fouled with tarballs. If parent birds become fouled by tarballs, they may subsequently foul the nest or their offspring. They may even feed their offspring prey contacted by tarballs.

Prior to washing up on beaches, tarballs persist in the sea. They may remain neutrally buoyant and suspended in the water column, or they may settle on the seafloor. Numerous marine organisms (including endangered and threatened cetaceans, manatees, and sea turtles) feed and ingest materials found in the water column or on the seafloor. These animals are at risk of ingesting oil or consuming prey contaminated or fouled by residual hydrocarbons introduced from an oil spill. The risk of exposure to marine protected species and their prey may last decades. The risk of exposure to tarballs or persistent hydrocarbons from an oil spill in the sea is less than the risk associated with exposure to an oil slick.

Analysis of Spill Risk to Air Quality

Oil exposed to the atmosphere has the potential to contribute to air pollutants through evaporation of the volatile components of the oil. The number of spills estimated to occur as a result of typical proposed actions in the WPA and CPA are presented in **Chapter 4.3.1.1**. Estimates of the contribution of spills to the total volume of volatile hydrocarbons are provided in **Chapters 4.2.1.1.1 and 4.2.2.1.1**.

Analysis of Spill Risk to Water Quality

The potential for spills to affect the quality of GOM coastal and marine waters is dependent on the frequency and volume of spills.

Risk from Offshore Spills

The MMS estimates that about 400-21,000 bbl of oil would be spilled in offshore waters over the 40-year life of a proposed action in the WPA and about 5,500-26,500 bbl of oil would be spilled in offshore waters over the 40-year life of a proposed action in the CPA. These volumes include volumes from spill incidents in all size groups.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting WPA and CPA proposed actions combined; most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

For offshore spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

Analysis of Spill Risk to Sensitive Coastal Environments

Sensitive coastal environments located in the GOM consist primarily of coastal barrier beaches, wetlands, and seagrass communities (**Chapter 3.2.1.3**).

Risk from Offshore Spills ≥1,000 bbl

Because of the widespread distribution of sensitive coastal environments along the Gulf Coast, specific resource locations were not analyzed by the OSRA model trajectory simulations. The probabilities of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was used as an indicator of the risk of a slick from such a spill reaching sensitive coastal environments. **Figures 4-13 and 4-14** show the GOM coastal counties and parishes having a risk >0.5 percent of being contacted within 10 days by an offshore spill ≥1,000 bbl occurring as a result of a proposed action. Most counties and parishes have a <0.5 percent probability of a spill ≥1,000 bbl occurring and contacting (combined probability) their shorelines within 10 days; six counties in Texas and eight parishes in Louisiana have a 1-15 percent chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline within 10 days. In Louisiana, Plaquemines Parish has the greatest risk (10-15%) of a spill occurring and contacting its shoreline within 10 days as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk (3-5%) of being contacted within 10 days by a spill occurring offshore as a result of a WPA proposed action.

Tables 4-36 and 4-37 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km (0.6 mi) of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km (6-31 mi) of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Offshore Spills <1,000 bbl

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting the WPA and CPA proposed actions combined. Most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action will have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, sensitive coastal environments located near the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 80 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be to be brought into this area. Sensitive coastal environments in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. The greatest risk of contact would be from the assumed 3,000-bbl spill should it occur within or near wetlands.

Analysis of Spill Risk to Continental Shelf Benthic Resources

The live bottoms (topographic features and pinnacle trend) sustaining sensitive benthic communities are listed and described in **Chapters 4.2.1.1.4.1 and 4.2.2.1.4.1**.

Risk from Offshore Spills

All evidence to date indicates that oil discharges that occur at the seafloor from a pipeline or loss of well control would rise in the water column, surfacing almost directly over the source location (**Chapter 4.3.1.5.4**). Therefore, a subsurface oil spill would have to occur very close to a topographic or pinnacle trend feature for the rising oil to contact the feature. There is a 24-32 percent chance that one pipeline spill ≥1,000 bbl would occur and a 4-9 percent chance that a second pipeline spill ≥1,000 bbl would occur as a result of a WPA proposed action. There is a 30-37 percent chance that one pipeline spill ≥1,000 bbl would occur, a 20-27 percent chance that a second pipeline spill ≥1,000 bbl would occur, and a 7-16 percent chance that a third pipeline spill ≥1,000 bbl would occur as a result of a CPA proposed action. For a proposed action in the WPA, 1-2 losses of well control are estimated to occur during the 40-year analysis period, and 2-3 losses of well control are estimated to occur from a proposed action in the CPA. No pipeline spill or losses of well control would occur within 1,000 m (3,281 ft) of a topographic or pinnacle trend feature because lease stipulations prohibit drilling or pipeline emplacement within 1,000 m (3,281 ft) of identified live-bottom features.

Once the oil from a subsea spill reaches the sea surface, the slick behaves similarly to a slick from a surface spill. Oil from a surface slick can be driven into the water column. Measurable amounts have been documented down to a 10-m (33 ft) depth, and modeling exercises have indicated such oil may reach a depth of 20 m (66 ft). As the crests of topographic and pinnacle trend features in the northern Gulf are primarily deeper than 20 m (66 ft), with the exception of the features within the Flower Gardens Banks National Marine Sanctuary, oil from a surface spill is unlikely to reach the sessile biota of these live-bottom features.

The tops of the shallowest features in the Flower Gardens Banks National Marine Sanctuary are at approximately 15 m below sea level. If oil in a slick passing over the sanctuary were driven into the water column as deep as 15 m or more, biota in the sanctuary could be contacted. The likelihood of a surface slick from a spill associated with proposed action operations passing over the Sanctuary was calculated by the MMS's trajectory model (**Figure 4-16**). For a WPA proposed action, there is a 4-7 percent risk of an oil spill occurring and the surface slick passing over the Flower Garden, and 2-4 percent chance of a spill occurring and the surface slick passing over Stetson Bank. For a CPA proposed action, there is a 2-3 percent risk of an oil spill occurring, and the surface slick passing over the Flower Garden, and up to a 1 percent chance of a spill occurring and the surface slick passing over Stetson Bank.

Analysis of Spill Risk to Continental Slope and Deepwater Resources

Deepwater benthic communities include both chemosynthetic and nonchemosynthetic communities (**Chapter 3.2.2.2**). Chemosynthetic communities occur in water depths of >400 m (1,312 ft).

Risk from Offshore Spills

All evidence to date indicates that oil discharges that occur at the seafloor from a pipeline or losses of well control would rise in the water column, surfacing almost directly over the source location (**Chapter 4.3.1.5.4**). Therefore, a subsurface oil spill would have to occur very close to a benthic community for rising oil to contact the benthic organisms. There is a 24-32 percent chance that one pipeline spill ≥1,000 bbl would occur and a 4-9 percent chance that a second pipeline spill ≥1,000 bbl would occur as a result of a WPA proposed action. There is a 30-37 percent chance that one pipeline spill ≥1,000 bbl would occur, a 20-27 percent chance that a second pipeline spill ≥1,000 bbl would occur, and a 7-16 percent chance that a third pipeline spill ≥1,000 bbl would occur as a result of a CPA proposed action. For a proposed action in the WPA, 1-2 losses of well control are estimated to occur during the 40-year analysis period, and 2-3 losses of well control are estimated to occur from a proposed action in the CPA. The likelihood that a pipeline spill or losses of well control would occur near a chemosynthetic community is extremely low, especially with consideration that NTL 2000-G20 prohibits drilling or pipeline emplacement within 1,500 ft of potential chemosynthetic communities.

The likelihood of weathered oil components from a surface slick reaching a deepwater chemosynthetic community in any measurable concentrations is very small.

Analysis of Spill Risk to Marine Mammals

Risk from Offshore Spills ≥1,000 bbl

Spills occurring in or being transported through coastal waters as a result of a proposed action may contact groups of bottlenose dolphin, Atlantic spotted dolphin, or the West Indian manatee. **Figure 4-17** depicts the locations of marine mammal habitats in coastal waters that were analyzed by the OSRA model. **Figure 4-17** also provides the probabilities of a spill ≥1,000 bbl occurring from a proposed action and the slick reaching identified marine mammal coastal habitats within 10 days. The OSRA modeling results indicate that there is a 10-16 percent probability of a spill ≥1,000 bbl occurring as a result of a proposed action in the WPA and the slick reaching the Texas State waters used by marine mammals within 10 days. The probability of an oil spill ≥1,000 bbl occurring as a result of a proposed action in the CPA and the slick reaching Texas coastal waters within 10 days is 2-3 percent. Coastal waters of Louisiana west of the Mississippi River have a 23-35 percent and 1-2 percent risk of being contacted within 10 days by a slick resulting from an offshore spill ≥1,000 bbl related to a proposed action in the CPA and WPA, respectively. There is a 6-9 percent risk of a spill occurring from a proposed action in the CPA and the slick contacting Louisiana coastal waters east of the Mississippi River mouth within 10 days. There is a 1 percent risk of a spill occurring from a proposed action in the CPA and the slick contacting Mississippi coastal waters within 10 days, and up to a 1 percent risk of contacting Alabama coastal waters. The OSRA model projected a <0.5 percent chance of a slick from a spill ≥1,000 bbl reaching the Florida coastal waters within 10 days as a result of any proposed action.

Figure 4-18 shows the geographic locations analyzed by the OSRA model to estimate the risk of oil-spill occurrence and contact to areas predictably used by manatees. The probability of a spill ≥1,000 bbl occurring from a proposed action and the slick reaching manatee areas within 10 days is <0.5 percent, except for the manatee habitat located off the shoreline from eastern Louisiana to Alabama. There is a 1-2 percent a risk of a spill ≥1,000 bbl occurring from a proposed action in the CPA, and reaching this manatee area.

Risk from All Offshore Spills

About 400-21,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 800-1,500 spill events as a result of a proposed action in the WPA, and about 5,500-26,500 bbl of oil is estimated to be spilled in offshore waters from the estimated 2,700-4500 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from 1-2 spill incidents in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl. While <1 spill is estimated for some sizes of spills (**Table 4-35**), there is always a finite chance of any size spill occurring. Therefore, the possibility of at least one spill of each size is included in the upper spill volume estimates.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting the WPA and CPA proposed actions combined; most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have low probability of occurrence.

Analysis of Spill Risk to Sea Turtles

Risk from Offshore Spills ≥1,000 bbl

Spills occurring as a result of a proposed action and oil slicks migrating through coastal waters could reach coastal sea turtle habitats. **Figure 4-20** maps the locations analyzed by the OSRA model in calculating the risk of an oil slick contacting the general, mating, and nesting habitats of sea turtles. The table below provides the geographic areas and months used for the OSRA model. Working with FWS, MMS determined the months (listed in the table below) when sea turtles used the identified coastal habitats. The model results present the likelihood of slicks reaching the identified locations only during these months.

State	Geographic Area Type	Habitat Use	Seasonality
Tamaulipas	Coastal beaches	Nesting	April-September
Tamaulipas	State coastal waters	Mating	March-July
Tamaulipas	State coastal waters	General	year round
TX	Coastal beaches	Nesting	April-September
TX	State coastal waters	Mating	March-July
TX	State coastal waters	General	year round
LA	Chandeleur Islands	Nesting	April-November
LA	State coastal waters	General	year round
LA	Chandeleur Islands	Mating	March-July
MS-AL	Coastal beaches	Nesting	April-November
MS-AL	State coastal waters	Mating	March-July
MS-AL	State coastal waters	General	year round
FL Panhandle	Coastal beaches	Nesting	April-November
FL Panhandle	State coastal waters	Mating	March-July
FL Panhandle	State coastal waters	General	year round
FL peninsula	Coastal beaches	Nesting	April-November
FL Peninsula	State coastal waters	Mating	March-July
FL Peninsula	State coastal waters	General	year round
Tortugas	Coastal beaches	Nesting	April-November
Tortugas	State coastal waters	Mating	March-July
Tortugas	State coastal waters	General	year round

Figure 4-20 provides the likelihood of an offshore spill ≥1,000 bbl occurring from a proposed action and reaching the identified coastal sea turtle habitats within 10 days during the identified months of use.

The OSRA modeling results indicate that there is a 10-16 percent probability that a spill ≥1,000 bbl occurring as a result of a WPA proposed action and the slick reaching Texas waters used by sea turtles as general coastal habitat within 10 days after a spill event. There is a 6-10 percent chance that one or more spills would occur and the slick reaching Texas waters within 10 days after the spill occurrence during mating season. There is a <0.5-4 percent chance that a spill ≥1,000 bbl would occur from a WPA proposed action and the slick reaching shore within 10 days during Texas's sea turtle nesting season.

The probability of an offshore oil spill ≥1,000 bbl occurring as a result of a proposed action in the CPA and the slick reaching Louisiana coastal waters used by turtles as general coastal habitat within 10 days ranges from 6 to 35 percent. The Chandeleur Islands is the only area in Louisiana considered sea turtle habitat for mating and nesting; there is up to a 4 percent chance that this habitat would be contacted by slick from an offshore spill ≥1,000 bbl occurring as a result of a proposed action.

The OSRA model results show that there is a <0.5 percent chance that coastal areas in Mexico and Florida, when serving as sea turtle habitat, would be contacted by an oil slick resulting from an offshore spill ≥1,000 related to a proposed action. There is a <0.5 percent chance that coastal areas in Mississippi and Alabama, when serving as sea turtle habitat, would be contacted by an oil slick resulting from an offshore spill ≥1,000 related to a proposed action in the WPA. There is a 1 percent chance that coastal areas in Mississippi and a <0.5–1 percent chance that coastal areas in Alabama, when serving as sea turtle habitat, would be contacted by an oil slick resulting from an offshore spill ≥1,000 bbl occurring as a result of a CPA proposed action.

Tables 4-36 and 4-37 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km (0.6 mi) of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km (6-31 mi) of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from All Offshore Spills

The MMS estimates that about 400-21,000 bbl of oil would be spilled in offshore waters from an estimated 800-1,500 spills over the 40-year life of a proposed action in the WPA and about 5,500-26,500 bbl of oil would be spilled in offshore waters from an estimated 2,700-4,500 spills over the 40-year life of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from 1-2 spill incidents in the size class of ≥1,000 bbl and one in the size class of ≥10,000 bbl. This volume assumes one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl. While <1 spill is estimated for some sizes of spills (**Table 4-35**), there is always a finite chance of any size spill occurring. Therefore, the possibility of at least one spill of each size is included in the upper spill volume estimates.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting CPA and WPA proposed actions combined; most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

Analysis of Spill Risk to Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Risk from Offshore Spills ≥1,000 bbl

Figure 4-21 provides the results of MMS's analysis of the risk of a spill ≥1,000 bbl occurring offshore and reaching endangered beach mice habitat within 10 days as a result of a proposed action. There is a <0.5 percent chance that one or more offshore spills ≥1,000 bbl would occur and contact the shoreline inhabited by the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice during the life of a proposed action.

Risk from Offshore Spills <1,000 bbl

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Few, if any, coastal spills are estimated to occur in Alabama or Florida coastal waters as a result of a proposed action, because OCS oil is not barged or pipelined to shore in Alabama or Florida, the states where the beach mice are found.

Analysis of Spill Risk to Marine Birds

Risk from All Offshore Spills

About 400-21,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 800-1,500 spill events as a result of a proposed action in the WPA, and about 5,500-26,500 bbl of oil are estimated to be spilled in offshore waters from the estimated 2,700-4,500 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from 1-2 spill incidents in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl. While <1 spill is estimated for some sizes of spills (**Table 4-35**), there is always a finite chance of any size spill occurring. Therefore, the possibility of at least one spill of each size is included in the upper spill volume estimates.

For spills ≥1,000 bbl, there is a 5-10 percent chance of two spills, and a 1-2 percent chance of three spills occurring over the 40-year life of a WPA proposed action. For spills ≥1,000 bbl, there is a 21-27 percent chance of two spills, and an 8-18 percent chance of three spills over the next 40 years as a result of a CPA proposed action.

Analysis of Spill Risk to Coastal Birds

The risk of contact to coastal birds from spills related to proposed action operations is dependent upon the likelihood that a spill occurs and the likelihood that the spilled oil reaches the shore areas inhabited or used by these birds.

Risk from Offshore Spills ≥1,000 bbl

The risk of contact to coastal birds from offshore spills ≥1,000 bbl is dependent upon (1) the likelihood that oil spills occurring from proposed action operations could be transported to the shoreline identified as coastal bird habitats and (2) oil-spill contact occurs during the period that specific coastal birds are present in the area. **Figures 4-22 through 4-31** identify the shoreline areas representing identified coastal bird type habitat that were analyzed for spill risk. The following table lists the coastal bird types and the periods when the birds are expected to occupy identified habitats that were used for this OSRA model run.

Coastal Bird Type	When Birds Occupy Identified Habitat Areas
Diving birds	year round
Gulls, terns, charadriid allies	year round
Raptor birds	year round
Charadriid shorebirds	year round
Wading birds	year round
Waterfowl	year round
Brown pelican	year round
Whooping crane	November-April
Bald eagle	year round
Piping plover	July-May

Figures 4-22 through 4-31 also provide the results of MMS's model trajectory simulation. Probabilities shown represent the likelihood that a spill ≥1,000 bbl would occur offshore as a result of a proposed action and the slick would reach various coastal bird habitats during the periods when the birds are known to use the area and within 10 days after the spill incident. The probabilities of occurrence and contact within 10 days for all species and habitats modeled range between <0.5 and 35 percent.

In addition to accounting for wind and current transport and risk of spill occurrence, the combined probabilities incorporate the length of time each coastal bird type occupies the identified habitat. For example, the whooping crane occupies the identified habitat for 6 months out of the year. The chance of a spill occurring offshore and the slick reaching this habitat within 10 days during those 6 months is calculated to be <0.5-1 percent. In contrast, waterfowl are found everywhere along the Gulf's shoreline year round; thus, the risk of spill occurrence and contact is higher (23-35% from a proposed action in the CPA and 9-14% from a proposed action in the WPA). Given the widespread distribution of waterfowl throughout the Gulf Coast, if an oil spill from a proposed action were to occur and reach land, waterfowl habitat would likely be contacted.

Tables 4-36 and 4-37 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km (0.6 mi) of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km (6-31 mi) of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Offshore Spills <1,000 bbl

About 400-21,000 bbl of oil is estimated to be spilled in offshore waters over a 40-year period from the estimated 800-1,500 spill events as a result of a proposed action in the WPA, and about 5,500-26,500 bbl of oil is estimated to be spilled in offshore waters from the estimated 2,700-4,500 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from 1-2 spill incidents in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl. While <1 spill is estimated for some sizes of spills (**Table 4-35**), there is always a finite chance of any size spill occurring. Therefore, the possibility of at least one spill of each size is included in the upper spill volume estimates.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting the WPA and CPA proposed actions combined; most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, bird populations located near the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 80 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be brought into this area. Bird populations in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. The greatest risk of contact would be from the assumed 3,000-bbl spills should they occur within or near the identified habitat areas when the birds are occupying those habitats.

Analysis of Spill Risk to Gulf Sturgeon

In 1996, Gulf sturgeon occurred from the Mississippi River to Charlotte Harbor in western Florida (Patrick, personal communication, 1996). **Figure 4-19** shows this habitat.

Risk from Offshore Spills ≥1,000 bbl

Figure 4-19 provides the results of the analysis of the risk of a spill ≥1,000 bbl occurring offshore as a result of a proposed action and reaching the known locations of the Gulf sturgeon within 10 days after the spill event. The likelihood of a spill ≥1,000 bbl occurring within the WPA area and reaching locations used by the Gulf sturgeon within 10 days after the spill incident is <0.5 percent. There is a 6-9 percent chance that a spill ≥1,000 bbl would occur as a result of a proposed action in the CPA and reach coastal waters where the Gulf sturgeon has been found within 10 days. The risk of exposure of Gulf sturgeon to such a spill would be dependent upon the species abundance and density as well as the size and persistence of the slick.

Risk from All Offshore Spills

About 400-21,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 800-1,500 spill events as a result of a proposed action in the WPA, and about 5,500-26,500 bbl of oil are estimated to be spilled in offshore waters from the estimated 2,700-4,500 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from 1-2 spills incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl. While <1 spill is estimated for some sizes of spills (**Table 4-35**), there is always a finite chance of any size spill occurring. Therefore, the possibility of at least one spill of each size is included in the upper spill volume estimates.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

The coastal waters inhabited by the Gulf sturgeon are not expected to be at risk from coastal spills resulting from a proposed action considering the projected use of shore bases in support of activities resulting from a proposed action (**Chapter 4.1.2.1.1**), very few of the estimated 46-102 coastal spills resulting from a proposed action in the CPA are likely to occur east of the Mississippi River. No coastal spills are projected to occur in Mississippi, Alabama, or Florida coastal waters as a result of a proposed action in the CPA.

Analysis of Spill Risk to Fish Resources, Essential Fish Habitats, and Commercial Fisheries

The essential fish habitat (EFH) for the GOM includes all estuarine and marine waters and substrates from the shoreline to the seaward limit of the U.S. Exclusive Economic Zone (EEZ). Coastal areas that are considered EFH include wetlands and areas of submerged vegetation. Live-bottom features and their biotic assemblages are also considered EFH. Any spill that occurs as a result of a proposed action will contact EFH.

Risk from Offshore Spills ≥1,000 bbl

Figure 4-14 shows that there is a 21-27 percent chance of two spills ≥1,000 bbl occurring from a proposed action in the CPA over the next 40 years, and **Figure 4-13** shows a 5-10 percent chance of two spills ≥1,000 occurring from a proposed action in the WPA.

Risk from All Offshore Spills

The MMS estimates that about 400-21,000 of oil would be spilled in offshore waters from an estimated 800-1,500 spills over the 40-year life of a proposed action in the WPA and about 5,500-26,500 bbl of oil would be spilled in offshore waters from an estimated 2,700-4,500 spills over the 40-year life of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size class of ≥1,000 bbl and one in the size class of ≥10,000 bbl. While <1 spill is estimated for some sizes of spills (**Table 4-35**), there is always a finite chance of any size spill occurring. Therefore, the possibility of at least one spill of each size is included in the upper spill volume estimates.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting CPA and WPA proposed actions combined; most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, the most likely locations of the 6-15 coastal spills >1 bbl estimated to occur from operations related to the proposed actions are the coastal locations proximate to the major oil pipeline shore facilities. Sensitive coastal resources located within the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 80 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be brought into this area. Sensitive coastal resources located in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills related to CPA proposed action support operations. The greatest risk of contact would be from the assumed 3,000-bbl spills should thes occur when and where fish species are most vulnerable.

Analysis of Spill Risk to Recreational Beaches

The following table lists the major recreational beach areas and the timeframes analyzed for spill risk.

Recreational Beaches	Major Seasonal Use
Texas	
Coastal Bend Area Beaches	April-September
Matagorda Area Beaches	April-September
Galveston Area Beaches	April-September
Sea Rim State Park	April-September
Louisiana	
Beaches	April-November
Alabama/Mississippi	
Gulf Islands	April-November
Gulf Shores	April-November
Florida	
Panhandle Beaches	April-November
Big Bend Beaches	April-November
Southwest Beaches	April-November
Ten Thousand Islands	April-November

Risk of Offshore Spills ≥1,000 bbl

Figure 4-15 provides the results of the analysis of the risk of a spill ≥1,000 bbl occurring offshore as a result of a proposed action and reaching major recreational beach areas. The likelihood of a spill ≥1,000 bbl occurring from a proposed action in the WPA and reaching a Texas recreational beach area within 10 days is 1-4 percent. Western Louisiana beaches have a 1-2 percent chance that an oil spill ≥1,000 bbl would occur from a WPA proposed action and contact the area within 10 days.

The likelihood of a spill occurring from a CPA proposed action and contacting a recreational beach area in Texas is <0.5-1 percent. The likelihood of a spill ≥1,000 bbl occurring from a proposed action in the CPA and reaching recreational beaches in Louisiana within 10 days is 5-8 percent. The likelihood of a spill ≥1,000 bbl occurring from a proposed action in the CPA and reaching recreational beaches in Mississippi or Alabama within 10 days is <0.5-1 percent.

Tables 4-36 and 4-37 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km (0.6 mi) of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km (6-31 mi) of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

There is a <0.5 percent chance of a spill ≥1,000 bbl occurring from a proposed action and reaching recreational beaches in Florida within 10 days.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting the WPA and CPA proposed actions combined; most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

Analysis of Spill Risk to Archaeological Resources

Since possible locations of historic and prehistoric resources are widespread along the Gulf Coast, specific resource locations were not analyzed by the OSRA model trajectory simulations.

Risk from Offshore Spills ≥1,000 bbl

The probabilities of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was used as an indicator of the risk of an offshore spill reaching archaeological resources. **Figures 4-13 and 4-14** show the GOM coastal counties and parishes having a risk >0.5 percent of being contacted within 10 days by an offshore spill ≥1,000 bbl occurring as a result of a proposed action. Most counties and parishes have a <0.5 percent probability of a spill ≥1,000 bbl occurring and contacting (combined probability) their shorelines within 10 days; six counties in Texas and eight parishes in Louisiana have probabilities of 1-15 percent of an OCS offshore spill ≥1,000 bbl occurring and reaching their shorelines within 10 days. In Louisiana, Plaquemines Parish has the greatest risk (10-15%) of a spill occurring and contacting its shoreline within 10 days as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk (3-5%) of being contacted within 10 days by a slick occurring offshore as a result of a WPA proposed action.

Tables 4-36 and 4-37 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km (0.6 mi) of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km (6-31 mi) of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Coastal Spills

Approximately 61-136 spills are estimated to occur within Gulf coastal waters from activities supporting CPA and WPA proposed actions combined; most (about 90%) of these spills would be ≤1 bbl. The most likely locations of the estimated 6-15 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for two 3,000-bbl spills estimated to occur in Louisiana and Texas coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

4.3.2. Losses of Well Control

A loss of well control (LWC) is the uncontrolled flow of a reservoir fluid that may result in the release of gas, condensate, oil, drilling fluids, sand, or water. Loss of well control is a broad term that includes very minor up to the most serious well control incidents, while blowouts are considered to be a subset of more serious incidents with greater risk of oil spill or human injury. Historically, most LWC have occurred during development drilling operations, but LWC can happen during exploratory drilling, production, well completions, or workover operations. The LWC may occur during drilling between zones in the wellbore or may occur at the seafloor. One-third of LWC were associated with shallow gas flows. Most LWC last for a short duration, with half lasting less than a day.

From 1992 to 2005, a total of 62 LWC's have occurred in the GOM OCS. From 1995 to 2000, the LWC rate rose from 1 per 1,000 well starts to 6 per 1,000 well starts. From 2001 to 2005, the LWC rate remained at 6 per 1,000 well starts. For this EIS, a LWC rate of 6 per 1,000 well starts is used.

Loss of well control may result in the release of synthetic drilling fluid or loss of oil. From 1996 to 2005, 21 percent of LWC resulted in spilled oil or SBF, or released gas or condensate. Of the 62 LWC's that have occurred during this period, the following 10 resulted in oil, condensate, or SBF release:

Year	Amount Spilled	Water Depth
2004	5.4 bbl condensate and oil	7 m (23 ft)
2004	11 bbl crude	1,175 m (3,855 ft)
2003	0.02 bbl condensate	60 m (197 ft)
2003	10 bbl condensate	9 m (30 ft)
2002	350 bbl crude	15 m (50 ft)
2002	0.5 bbl condensate	NA
2001	1 bbl SBF	393 m (1,290 ft)
2000	0.5 bbl of oil	94 m (309 ft)
2000	806 bbl SBF and 150-200 bbl of crude oil	678 m (2,223 ft)
1998	1.5 bbl of condensate	16 m (51 ft)

In 1997, an MMS-funded study on the fate and behavior of oil well blowout (S.L. Ross Environmental Research Ltd., 1997). Oil well blowouts generally involve two fluids—crude oil (or condensate) and natural gas. A highly turbulent zone occurs within a few meters of the discharge point and then rapidly loses momentum with distance. In water depths <300 m, the flow of natural gas determines the initial dimensions of oil slicks from subsea blowouts. As the gas rises, it entrains oil and water in the vicinity and carries them to the surface. In these water depths, currents have little effect compared to the plume's velocity. In deeper water (>300 m) with lower temperatures and higher pressures, gas may form hydrates and the volume of gas may be depleted through dissolution into the water. Larger droplets will reach the surface faster and closer to the source, while smaller droplets will be carried farther by the currents before reaching the surface.

Severe subsurface LWC could resuspend and disperse abundant sediments within a 300-m radius from the LWC site. The fine sediment fraction could be resuspended for more than 30 days. The coarse sediment fraction (sands) would settle at a rapid rate within 400 m (1,312 ft) from the loss of well control site, particularly in a 30-m water depth and a 35-cm/s (14 in/s) loss of well control scenario.

Prior to the 1980's, blowouts were the leading cause of fatalities on the OCS. The most recent blowout-related fatality occurred in 2001.

The MMS requires the use of blowout preventers (BOP) and BOP system testing at specific times: (1) when installed, (2) before 14 days have elapsed since the last BOP pressure test, and (3) before "drilling out" each string of casing or a liner (30 CFR 250.407). A 1996 MMS-funded study looked at the reliability of BOP's (Tetrahedron, Inc., 1996). This study found that subsea BOP's had a lower failure rate (28%) than surface BOP's (44%). A test was considered to have failed if any piece of equipment had to be physically repaired or sent for repairs after the test.

An estimated 1-2 LWC events could occur from activities resulting from a proposed action in the WPA. An estimated 2-3 LWC events could occur from activities resulting from a proposed action in the CPA.

For OCS Program activities in the WPA of the GOM for the years 2007-2046, the estimated total number of LWC events is 63-75. For OCS Program activities in the CPA of the GOM for the years 2007-2046, the estimated total number of LWC events is 169-197.

4.3.3. Vessel Collisions

The MMS data show that, from 1996 to 2005, there were 129 OCS-related collisions. Most collision mishaps are the result of service vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10 percent of vessel collisions with platforms in the OCS caused diesel spills. Fires resulted from hydrocarbon releases in several of the collision incidents. To date, the largest diesel spill associated with a collision occurred in 1979 when an anchor-handling boat collided with a drilling platform in the Main Pass Area, spilling 1,500 bbl. Diesel fuel is the product most frequently spilled while corrosion inhibitor, hydraulic fluid, lube oil, and methanol have also been released as the result of a vessel collision.

Safety fairways, traffic separation schemes, and anchorages are the most effective means of preventing vessel collisions with OCS structures. In general, fixed structures such as platforms and drilling rigs are prohibited in fairways. Temporary underwater obstacles, such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs, may be placed in a fairway under certain conditions. A limited number of fixed structures may be placed at designated anchorages. The USCG's requirements for indicating the location of fixed structures on nautical charts and for lights, sound-producing devices, and radar reflectors to mark fixed structures and moored objects also help minimize the risk of collisions. In addition, the USCG 8th District's Local Notice to Mariners (monthly editions and weekly supplements) informs GOM users about the addition or removal of drilling rigs and platforms, locations of aids to navigation, and defense operations involving temporary moorings. Marked platforms often become aids to navigation for vessels (particularly fishing boats and vessels supporting offshore oil and gas operations) that operate in areas with high densities of fixed structures.

The National Offshore Safety Advisory Committee (NOSAC, 1999) examined collision avoidance measures between a generic deepwater structure and marine vessels in the GOM. The NOSAC offered three sets of recommendations: (1) voluntary initiatives for offshore operators; (2) joint government/industry cooperation or study; and (3) new or continued USCG action. The NOSAC (1999) proposes that oil and gas facilities be used as aids-to-navigation because of their proximity to fairways, fixed nature, well-lighted decks, and inclusion on navigational charts. Mariners intentionally set and maintain course toward these facilities, essentially maintaining a collision course. Unfortunately, most deepwater facilities do not install collision avoidance radar systems to alert offshore facility personnel of a potentially dangerous situation. The NOSAC estimates that 7,300 large vessels (tankships, freight ships, passenger ships, and military vessels) pass within 35 mi of a typical deepwater facility each year. This estimate resulted in approximately 20 transits per day for the 13 deepwater production structures existing in 1999. The NOSAC found the total collision frequency to be approximately one collision per 250 facility-years (3.6×10^{-3} per year). The NOSAC estimated that if the number of deepwater facilities increases to 25, the estimated total collision frequency would increase to one collision in 10 years. A cost-benefit analysis within the report did not support the use of a dedicated standby vessel for the generic facility; however, the analysis did support the use of a radar system on deepwater facilities if the annual costs of the system were less than or equal to $124,500.

The OCS-related vessels could collide with marine mammals, turtles, and other marine animals during transit. To limit or prevent such collisions, NOAA Fisheries Service provides all boat operators with "Whalewatching Guidelines," which is derived from the Marine Mammal Protection Act. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. The frequency of vessel collisions with marine mammals, turtles, or other marine animals probably varies as a function of spatial and temporal distribution patterns of the living resources, the pathways of maritime traffic (coastal traffic is more predictable than offshore traffic), and as a function of vessel speed, the number of vessel trips, and the navigational visibility.

Chapter 3.3.5.7.3 discusses damage to platforms from recent hurricanes. Platforms destroyed by hurricane force winds and waves become potential obstructions to offshore operators and mariners in the GOM. To prevent any further incidents in regard to collisions with submerged or destroyed platforms, MMS, in December 2005, published a safety alert that provided the location of all facilities that were destroyed by Hurricanes Katrina and Rita. In the month prior to the safety alert, there were three separate incidents of vessels striking submerged platforms. All incidents resulted in potential pollution events, and one of the vessels sank. A barge transporting Fuel Oil #6 from Houston, Texas, to Tampa, Florida, struck a submerged platform about 30 mi off of the Texas coast and sank in November 2005. The spilled fuel oil was denser than water and sank to the seafloor. Oil from both the vessel and seafloor was recovered. Although the event is still under investigation, an estimated 74,900 bbl of #6 fuel oil was not recovered.

4.3.4. Chemical and Drilling-Fluid Spills

Chemicals are used to condition drill muds in completions, stimulation, and workover processes and during production. Chemicals are stored offshore in quantities related to their uses. Only two chemical spills of ≥1,000 bbl have occurred between 1964 and 2005. Between 5 and 15 chemical spills are anticipated each year, with the majority being <50 bbl in size. The most common chemicals spilled are methanol, ethylene glycol, and zinc bromide. Additional production chemicals are needed in deepwater operations where hydrate formation is a possibility, but spill volumes are anticipated to remain the same because of advances in subsea processing.

A study of chemical spills from OCS activities determined that only two chemicals could potentially impact the marine environment—zinc bromide and ammonium chloride (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and therefore are not in continuous use; thus, the risk of a spill for these chemicals is very small. Most other chemicals are either nontoxic or used in small quantities.

Zinc bromide is of particular concern because of the toxic nature of zinc. The study modeled a spill of 45,000 gallons of a 54-percent aqueous solution, which would result in an increase in zinc concentrations to potentially toxic levels. Direct information on the toxicity of zinc to marine organisms is not available; however, the toxicity of zinc to a freshwater crustacean (*Ceriodaphnia dubia*) indicated that exposure to 500 ppb zinc results in measurable effects. One factor not considered in the model is the rapid precipitation of zinc in marine waters, which would minimize the potential for impact.

Ammonium chloride was modeled using potassium chloride as a surrogate. The model looked at a spill of 4,717 kg of potassium chloride powder. The distribution of potassium would overestimate the distribution of ammonia released during a spill. The model indicated that close to the release point, ammonia concentrations could exceed toxic levels for time scales of hours to days. Additional information on the degradation of ammonia in seawater would be needed for a more complete evaluation.

In a study of sublethal effects of production chemicals on fish associated with platforms, the simultaneous exposure to methanol and ethylene glycol had a greater effect than exposure to either chemical alone. Swimming performance was the outcome studied (Baltz and Chesney, 2005).

Synthetic-based fluids have been used since the mid 1990's. Three SBF spills of ≥1,000 bbl occurred between 2001 and 2004. Between 5 and 20 synthetic-based fluid releases are anticipated each year, with the majority being <50 bbl in size (**Table 4-39**). The volume of the synthetic portion of the drill fluid rather than the total volume of the drill fluid is now used to describe spill size. Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when SBF are in use (**Table 4-49**). Each of the three releases occurred as a result of unplanned riser disconnect or failure. The number of disconnects is expected to remain the same as activity increases in deep water. However the rate is expected to decrease, because each accident is investigated, the cause is determined and publicized, so that it may be be prevented in the future.

Hurricanes in 2004 and 2005 resulted in an increased chemical spills and loss of containerized chemicals overboard. Mud slides, submerged and drifting rigs, and debris can damage pipelines and supply lines on the seafloor. A loose anchor that fractured a subsea methanol distribution line was the apparent cause of a 4,834-bbl methanol release that occurred over a 3-month period following Hurricane Ivan. Hurricane-related chemical and synthetic-based fluid releases may occur during the hurricane or afterwards when operations are brought back online. The MMS has requested operators to submit lists of all lost inventory to record chemical losses as a result of hurricanes.

4.3.5. Spill Response

4.3.5.1. MMS Spill Response Requirements and Initiatives

To ensure that industry maintains effective oil-spill-response capabilities, MMS

- requires immediate notification for spills >1 bbl – all spills require notification to the USCG and MMS receives notification from the USCG of all spills ≤1 bbl;
- conducts investigations to determine the cause of a spill;
- assesses civil and criminal penalties, if needed;
- oversees spill source control and abatement operations by industry;
- sets requirements and reviews and approves oil-spill response plans for offshore facilities;
- conducts unannounced drills to ensure compliance with oil-spill response plans;
- requires operators to ensure that their spill-response operating and management teams receive appropriate spill-response training;
- conducts inspections of oil-spill response equipment;
- requires industry to show financial responsibility to respond to possible spills; and
- provides research leadership to improve the capabilities for detecting and responding to an oil spill in the marine environment.

4.3.5.2. Offshore Response and Cleanup Technology

A number of cleanup techniques are available for response to an oil spill. Open-water response options include mechanical recovery, chemical dispersion, in-situ burning, or natural dispersion. Although bioremediation was at one time considered for use in open water, studies have shown that this technique is not an effective spill-response option in open water because of the high degree of dilution of the product and the rapid movement of oil in open water. Effective use of bioremediation requires that the products remain in contact with the oil for extended periods of time.

Single or multiple spill-response cleanup techniques may be used in abating a spill. The cleanup technique chosen for a spill response will vary depending upon the unique aspects of each situation. The selected mix of countermeasures will depend upon the shoreline and natural resources that may be impacted; the size, location, and type of oil spilled; weather; and other variables. The overall objective of on-water recovery is to minimize the risk of impact by preventing the spread of free-floating oil. The physical and chemical properties of crude oil can greatly affect the effectiveness of containment and recovery equipment, dispersant application, and *in-situ* burning. It is expected that oil found in the proposed lease sale areas could range from a medium-weight oil to condensates.

Mechanical Cleanup

Generally, mechanical containment and recovery is the primary oil-spill-response method used (33 CFR 153.305(a)). Mechanical recovery is the process of using booms and skimmers to pick up oil from the water surface. In a typical offshore oil-spill scenario, a boom is deployed in a V, J, or U configuration to gather and concentrate oil on the surface of the water. The oil is gathered in the wide end of the boom (front) and travels backward toward the narrow apex of the boom (back). The skimmer is positioned at the apex of the boom, where the oil is the thickest. The skimmer recovers the oil by sucking in the top layer via a weir skimmer, or the oil adheres to and is removed from a moving surface (i.e., an oleophylic skimmer). The oil is then pumped from the skimmer to temporary storage on an attendant vessel or barge, the latter of which serves as the skimming platform. When this on-board storage is full, the oil must be pumped into a larger storage vessel.

Mechanical oil-spill-response equipment that is contractually available to the operators through Oil Spill Removal Organization (OSRO) membership or contracts would be called out to respond to an offshore spill in the proposed lease sale areas. Each individual operator's response to a spill would differ according to the location of the spill, the volume and source of the spill, the OSRO under contract, etc. At this time, in the Gulf of Mexico, there are three major OSRO's that can respond to spills in the open ocean: (1) Clean Gulf Associates, (2) Marine Spill Response Corporation (MSRC), and (3) National Response Corporation. The equipment owned by these OSRO's is strategically located near the busier port areas throughout the Gulf to service the oil and gas exploration and production operators and, in some cases, the marine transportation industry. Numerous smaller OSRO's that stockpile additional shoreline and nearshore response equipment are also located throughout the Gulf coastal area.

It is expected that the oil-spill-response equipment needed to respond to an offshore spill in the proposed lease sale areas could be called out from one or more of the following oil-spill equipment base locations: Corpus Christi, Aransas Pass, Houston, La Porte, Ingleside, Port Arthur, and Galveston, Texas; Lake Charles, New Iberia, Belle Chase, Cameron, Cocodrie, Morgan City, New Orleans, Sulphur, Houma, Fourchon, Fort Jackson, and Venice, Louisiana; Pascagoula, Mississippi; Theodore and Mobile, Alabama; or Pensacola, Ft. Lauderdale, Panama City, and Tampa, Florida. Response times for any of this equipment would vary, dependent on the location of the equipment, the staging area, and the spill site; and on the transport requirements for the type of equipment procured.

It is assumed that 10-30 percent of an oil spill in an offshore environment can be mechanically removed from the water prior to the spill making landfall (U.S. Congress, Office of Technology Assessment, 1990).

Should an oil spill occur during a storm, spill response from shore would occur following the storm. Spill response would not be possible while storm conditions continued, given the sea state limitations for skimming vessels and containment boom deployment. However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high end aromatic compounds present).

Dispersants

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced. This allows normal wind and wave action to break the oil into tiny droplets, which are dispersed into the upper portion of the water column. Natural processes then break down these droplets much quicker than they would if the oil were allowed to remain on the water surface.

Dispersant use must be in accordance with the Regional Response Teams' Preapproved Dispersant Use Manual and any conditions outlined within a Regional Response Team site-specific dispersant approval given after a spill event. Consequently, dispersant use would be in accordance with the restrictions for specific water depths, distances from shore, or monitoring requirements. For a deepwater >1,000 ft water depth) spill $\geq$1,000 bbl, dispersant application may be a preferred response in the open-water environment to prevent oil from reaching a coastal area, in addition to mechanical response.

Based on the present location of dispersant stockpiles and dispersant application equipment in the Gulf of Mexico, it is expected that the dispersants and dispersant application aircraft initially called out for an oil-spill response to an offshore spill in the proposed lease sale area will come from Houma, Louisiana. Response times for this equipment would vary, depending on the spill site and on the transport time for additional supplies of dispersants to arrive at a staging location. Based on historic information, this EIS assumes that dispersant application will be effective on 20-50 percent (S.L. Ross Environmental Research Ltd., 2000) of the treated oil.

Should an oil spill occur during a storm, dispersant application would occur following the storm. Aerial and vessel dispersant application would not be possible while storm conditions continued. However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high-end aromatic compounds present).

In-situ Burning

In-situ burning is an oil-spill cleanup technique that involves the controlled burning of the oil at or near a spill site. The use of this spill-response technique can provide the potential for the removal of large amounts of oil over an extensive area in less time than other techniques. *In-situ* burning involves the same oil collection process used in mechanical recovery, except instead of going into a skimmer, the oil is funneled into a fire-boom, a specialized boom that has been constructed to withstand the high temperatures from burning oil. Fire resistant booms are used to isolate the oil from the source of the slick. The oil in the fire-boom is then ignited and allowed to burn. While *in-situ* burning is another method for disposing of oil that has been collected in a boom, this method is typically more effective than skimmers when the oil is highly concentrated.

For oil to ignite on water, it must be at least 2-3 mm thick. Most oils must be contained with fireproof boom to maintain this thickness. Oils burn at a rate of 3-4 mm per minute. Most oils will burn, although emulsions may require treatment before they will burn. Water in the oil will affect the burn rate; however, recent research has indicated that this effect will be marginal. One approximately 200–m length of fire resistant boom can contain up to 355 bbl (11,000 gallons) of oil, which takes about 45 minutes to burn. In total, it would take about three hours to collect this amount of oil, tow it away from a slick, and burn it (Fingas, 2001). Response times for bringing a fire-resistant boom onsite would vary, dependent on the location of the equipment, the staging area, and the spill site.

Should an oil spill occur during a storm, *in-situ* burning would occur following the storm. *In-situ* burning would not be possible while storm conditions continued.

Natural Dispersion

In some instances, the best response to a spill may be to allow the natural dispersion of a slick to occur. Natural dispersion may be a preferred option for smaller spills of lighter nonpersistent oils and condensates that form slicks that are too thin to be removed by conventional methods and are expected to dissipate rapidly, particularly if there are no identified potential impacts to offshore resources and a potential for shoreline impact is not indicated. In addition, natural dispersion may also be a preferred option in some nearshore environments when the potential damage caused by a cleanup effort could cause more damage than the spill itself.

4.3.5.3. Oil-Spill Response Assumptions Used in the Analysis of a Most Likely Spill ≥1,000 bbl Incident Related to a Proposed Action

Refer to **Tables 4-36 and 4-37** for the estimated amounts of oil that will either be removed by the application of dispersants or mechanically recovered for 4,600-bbl pipeline spill scenarios analyzed in this EIS. These tables reflect recovery and removal estimates for different scenarios:

- a 4,600-bbl spill of 35° API oil lost over 12 hours as a result of a potential pipeline break during winter conditions at High Island Area; and
- a 4,600-bbl spill of 30° API oil lost over 12 hours as result of a potential pipeline break during summer conditions at Ship Shoal Area;

The assumptions used in calculating the amounts removed as a result of dispersant use and mechanical recovery efforts for the two 4,600-bbl spill scenarios are listed below.

- The spills occurred and were reported at 6 a.m.
- The 35° API oil did not emulsify; the 30° API oil did emulsify.
- Spill-response efforts were conducted during daylight hours only. A 12-hr operational window was assumed for both the winter and summer season.

- Mechanical response equipment (i.e., fast-response units having a USCG de-rated skimming capacity of 3,400 bbl/day) owned by the oil-spill-response cooperative, Clean Gulf Associates, was procured from Galveston, Texas and Lake Charles, Louisiana, for response to the High Island Area Block A-425 scenario.
- Mechanical response equipment (i.e., fast-response units having a USCG de-rated skimming capacity of 3,400 bbl/day) owned by the oil-spill-response cooperative, Clean Gulf Associates, was procured from Houma and Venice Louisiana, for response to the Ship Shoal Area Block 281 scenario.
- Dispersant application aircraft was deployed for all of the scenarios from Houma, Louisiana. This location also served as the staging location for loading dispersants. Three aircraft from this location were deployed for dispersant application - two DC3's and one DC4.
- Sea-state conditions: during the summer waves were 2 ft; during the winter waves were 4 ft.
- A dispersant effectiveness rate of 30 percent was assumed for the treated oil. (S.L. Ross Environmental Research Ltd., 2000).
- Because of the projected stable emulsion formation of the 30° API, it was assumed that dispersant application would no longer be effective after 48 hr in this scenario.

4.3.5.4. Onshore Response and Cleanup

Offshore response and cleanup is preferable to shoreline cleanup; however, if an oil slick reaches the coastline it is expected that the specific shoreline cleanup countermeasures identified and prioritized in the appropriate Area Contingency Plans (ACP's) for various habitat types would be used. The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. Shorelines of low productivity and biomass can withstand more intrusive cleanup methods such as pressure washing. Shorelines of high productivity and biomass are very sensitive to intrusive cleanup methods, and in many cases, the cleanup is more damaging than allowing natural recovery.

Oil-spill response planning in the United States is accomplished through a mandated set of interrelated plans. The ACP represents the third tier of the National Response Planning System and was mandated by OPA 90. The ACP's cover subregional geographic areas. The ACP's are a focal point of response planning, providing detailed information on response procedures, priorities, and appropriate countermeasures. The Gulf coastal area that falls within USCG District 8 is covered by the One Gulf Plan ACP, which includes separate Geographic Response Plans for areas covered by USCG Sector Corpus Christi, Sector Houston/Galveston, Sector Port Arthur, Sector Morgan City, Sector New Orleans, and Sector Mobile. The Miami ACP covers the remaining Gulf coastal area. The ACP's are written and maintained by Area Committees assembled from Federal, State, and local governmental agencies that have pollution response authority; nongovernmental participants may attend meetings and provide input. The coastal Area Committees are chaired by respective Federal On-Scene Coordinators from the appropriate USCG Office and are comprised of members from local or area-specific jurisdictions. Response procedures identified within an ACP or its Geographic Response Plan(s) reflect the priorities and procedures agreed to by members of the Area Committees.

The single most frequently recommended spill-response strategy for the areas identified for protection in all of the applicable ACP's or it's Geographic Response Plans is the use of a shoreline boom to deflect oil away from coastal resources such as seagrass beds, marinas, resting areas for migratory birds, bird and turtle nesting areas, etc. If a shoreline is oiled, the selection of the type of shoreline remediation to be used will depend on the following: (1) the type and amount of oil on the shore; (2) the nature of the affected coastline; (3) the depth of oil penetration into the sediments; (4) the accessibility and the ability of vehicles to travel along the shoreline; (5) the possible ecological damage of the treatment to the shoreline environment; (6) weather conditions; (7) the current state of the oil; and (8) political considerations.

Shoreline Cleanup Countermeasures

The following assumptions regarding the cleanup of spills that contact coastal resources in the area of consideration reflect a generalization of the site-specific guidance provided in the ACP's or its Geographic Response Plans applicable to the Gulf of Mexico. The ACP's applicable to the Gulf coastal area cover a vast geographical area. The differences in the response priorities and procedures among the various ACP's or its Geographic Response Plans reflect the differences in the identified resources needing spill protection in the area covered by each ACP or its Geographic Response Plans:

- *Barrier Island/Fine Sand Beaches Cleanup*: After the oiling of a barrier island/fine sand beach with a medium-weight oil, applicable cleanup options are manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, shore removal/replacement, and warm-water washing. Other possible shoreline countermeasures include low-pressure cold-water washing, burning, and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; passive collection (sorbents); high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting.

- *Fresh or Salt Marsh Cleanup*: In all cases, cleanup options that avoid causing additional damage to the marshes will be selected. After the oiling of a fresh or salt marsh with a medium-weight oil, the preferred cleanup option would be to take no action. Another applicable alternative would be trenching (recovery wells). Shore removal/replacement, vegetation cutting, or nutrient enhancement could be used. The option of using vegetation cutting as a shoreline countermeasure will depend upon the time of the year and will be considered generally only if re-oiling of birds is possible. Chemical treatment, burning, and bacterial addition as countermeasures under consideration. Responders are advised to avoid manual removal, passive collection, debris removal/heavy equipment, sediment removal, cold-water flooding, high- or low-pressure cold-water washing, warm-water washing, hot-water washing, slurry sand blasting, and shore removal/replacement.

- *Coarse Sand/Gravel Beaches Cleanup:* After the oiling of a coarse sand/gravel beach with a medium-weight oil applicable cleanup options are manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, and shore removal/replacement. Other possible shoreline countermeasures include low-pressure, cold-water washing; burning; warm-water washing; and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; passive collection (sorbents); high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting.

- *Exposed or Sheltered Tidal Flats Cleanup:* After the oiling of an exposed or sheltered tidal flat with a medium-weight oil, the preferred cleanup option is no action. Other applicable shoreline countermeasures for this resource include trenching (recovery wells) and cold-water deluge flooding. Other possible shoreline countermeasures listed include low-pressure, cold-water washing; vacuum; vegetation cutting; and nutrient enhancement. Responders are requested to avoid manual removal; passive collection; debris removal/heavy equipment; sediment removal; high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; and shore removal replacement.

- *Seawall/Pier Cleanup:* After the oiling of a seawall or pier with a medium-weight oil, the applicable cleanup options include manual removal; cold-water flooding; low- and high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; vacuum; and shore removal replacement. Other possible shoreline countermeasures listed include burning and nutrient enhancement. Responders are requested to avoid no action, passive collection (sorbents), trenching, sediment removal, and vegetation cutting.

4.4. Environmental and Socioeconomic Impacts of the Proposed Gulf Sales and Alternatives—Accidental Events

4.4.1. Impacts on Air Quality

The accidental release of hydrocarbons or chemicals from OCS-related activities will cause the emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere. Accidents, such as oil spills and blowouts, are a source of emissions related to OCS operations. Typical emissions from OCS accidents consist of hydrocarbons; only fires produce a broad array of pollutants, including all NAAQS-regulated primary pollutants. The criteria pollutants considered here are NO_2, CO, sulphur oxides (SO_x), VOC, PM_{10}, and $PM_{2.5}$.

An oil spill (assumed size of 4,600 bbl) from a pipeline break during the summer at a location 50 mi off Louisiana was modeled for a period of 10 days (**Table 4-36**). An oil spill (assumed size of 4,600 bbl) from a pipeline break during the winter at a location 65 mi off Texas was modeled for a period of 10 days (**Table 4-37**). At the end of 10 days, 30 percent of the CPA slick and 31 percent of the WPA slick were lost because of evaporation. The contribution of oil-spill emissions to the total VOC emission is small, about 0.5 percent.

In-situ burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10}, and would generate a plume of black smoke. Fingas et al. (1995) describes the results of a monitoring program of a burn experiment at sea. The program involved extensive ambient measurements during two experiments in which approximately 300 bbl of crude oil were burned. It found that during the burn, CO, SO_2, and NO_2 were measured only at background levels and were frequently below detection levels. Ambient levels of VOC were high within about 100 m (328 ft) of the fire but were significantly lower than those associated with a nonburning spill. Measured concentrations of PAH were low. It appeared that a major portion of these compounds was consumed in the burn.

McGrattan et al. (1995) modeled smoke plumes associated with in-situ burning. The results showed that the surface concentrations of particulate matter did not exceed the health criterion of 150 $\mu g/m^3$ beyond about 5 km (3 mi) downwind of an in-situ burn. This is quite conservative as this health standard is based on a 24-hr average concentration rather than a 1-hr average concentration. This appears to be supported by field experiments conducted off of Newfoundland and in Alaska.

In summary, the impacts from in-situ burning are temporary. Pollutant concentrations would be expected to be within the NAAQS. The air quality impacts from in-situ burning would therefore be minor.

Blowouts are accidents related to OCS oil and gas activities and are defined as an uncontrolled flow of fluids from a wellhead or wellbore. The air pollutant emissions from blowouts depend on the amount of oil and gas released, the duration of the accident, and the occurrence or not of fire during the blowout. The duration of most blowouts is short duration, and half of blowouts lasted less than half a day. Blowouts may result in the release of synthetic drilling fluid or loss of oil. From 1992 to 2005, less than 10 percent of blowouts have resulted in spilled oil, which ranged from 1.5 to 200 bbl. An estimated 2-3 blowouts could occur from activities resulting from a proposed action in the CPA and 1-2 blowouts from a proposed action in the WPA.

The presence of hydrogen sulfide (H_2S) within formation fluids occurs sporadically throughout the GOM OCS, which may be released during an accident. There has been some evidence that petroleum from deepwater plays contain significant amounts of sulfur. Encounters with H_2S in oil and gas operations have caused injury and death throughout the U.S., but none, to date, in the GOM region. H_2S concentrations in OCS vary from as low as a fraction ppm to as high as 650,000 ppm. The concentrations of H_2S found to date are generally greatest in the eastern portion of the CPA. The Occupational Safety and Health Administration’s permissible exposure limit for H_2S is 20 ppm, which is 30 times lower than the “immediately dangerous to life and health” of 100 ppm set by the National Institute for Occupational Safety and Health. At about 500-700 ppm loss of consciousness and possible death can occur in 30-50 minutes. H_2S is a toxic gas; at lower concentrations, it is readily recognized by the “rotten egg” smell. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage.

Summary and Conclusion

Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications.

4.4.2. Impacts on Water Quality

Accidental events that could impact water quality include spills of oil and refined hydrocarbons, spills of chemicals or drilling fluids, and collisions and LWC that result in spills. Water quality is altered and degraded by oil spills through the increase of petroleum hydrocarbons and their various transformation/degradation products in the water. The extent of impact from a spill depends on the behavior and fate of oil in the water column (e.g., movement of oil and rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time. The various fractions within the crude behave differently in water. The lighter ends are more water soluble and would contribute to acute toxicity. As the spill weathers, the aromatic components are more likely to exit the water. The heavier fractions are less water soluble and would partition to organic matter. This fraction is more likely to persist in sediments and would contribute to longer-term impacts.

The National Academy of Sciences (NRC, 2003) and Boesch and Rabalais (1987) have reviewed the fate and effects of spilled oil. In general, the impacts to water quality are greatest when a spill occurs in a confined area where it persists for a long period of time. In an environment where the oil can be dispersed or diluted, the impacts are reduced. Spills of opportunity are few and difficult to sample on short notice. The evaluation of impacts from a large spill on water quality is based on qualitative and speculative information.

4.4.2.1. Coastal Waters

The ability of coastal waters to assimilate spilled oil is affected by the shallowness of the environment. Large volumes of water are not available to dilute suspended oil droplets and dissolved constituents. Since oil does not mix with water and is usually less dense, most of the oil forms a slick at the surface. Small droplets in the water may adhere to suspended sediment and be removed from the water column. Oil contains toxic aromatic compounds such as benzene, toluene, xylenes, naphthalenes, and polynuclear aromatic hydrocarbons, which are soluble to some extent in water. The effect of these compounds on water quality depends on the circulation in the coastal environment, the composition of the spilled oil, and the length of time the oil is in contact with the water. Oil may also penetrate sand on the beach or be trapped in wetlands, where it can be re-released into the water some time after the initial spill.

4.4.2.2. Marine Waters

Oil Spills

The Gulf of Mexico has numerous natural hydrocarbon seeps as discussed in **Chapters 3.1.2.2 and 4.1.3.4**. The marine environment can be considered adapted to handling small amounts of oil released over time. Most of the oil spills that may occur as a result of a proposed action are expected to be ≤1 bbl (**Table 4-35**).

An oil spill ≥1,000 bbl at the water surface may result from a platform accident. Subsurface spills would occur from pipeline failure or a loss of well control. Most of the oil from a subsurface spill would likely rise to the surface and would weather and behave similarly to a surface spill, dependent upon a number of factors, particularly the characteristics of the released oil and oceanographic conditions. However, some of the subsurface oil may also get dispersed within the water column, as in the case of the *Ixtoc I* seafloor blowout. Evidence from a recent experiment in the North Sea indicates that oil released during a deepwater blowout would quickly rise to the surface and form a slick (Johansen et al., 2001).

Impacts from a deepwater oil spill would occur at the surface where the oil would be mixed into the water and dispersed by wind waves.

Once the oil enters the ocean, a variety of physical, chemical, and biological processes act to disperse the oil slick, such as spreading, evaporation of the more volatile constituents, dissolution into the water column, emulsification of small droplets, agglomeration sinking, microbial modification, photochemical modification, and biological ingestion and excretion. The water quality of marine waters would be temporarily affected by the dissolved components and small oil droplets that do not rise to the surface or are mixed down by surface turbulence. Dispersion by currents and microbial degradation remove the oil from the water column or dilute the constituents to background levels.

The most likely oil-spill scenario for spills ≥1,000 bbl is a 4,600-bbl spill from a pipeline break that leaks for 12 hr. For a likely spill in the CPA, after three days, approximately 1 percent of the oil is expected to naturally disperse and about 45 percent is expected to be chemically dispersed. For the WPA, by two days, approximately 42 percent would be dispersed and 1,040 bbl chemically dispersed. The volume of oil is small relative to the amount of oil that enters the Gulf of Mexico through natural seeps; however, this represents a large quantity over a short period of time. Because the Gulf is a large body of water, the toxic constituents, such as benzene, toluene, xylene, and naphthalene, are expected to rapidly disperse to sublethal concentrations.

Chemical Spills

A recent study of chemical spills from OCS activities determined that accidental releases of zinc bromide and ammonium chloride could potentially impact the marine environment (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and are not in continuous use; thus, the risk of a spill is small. Most other chemicals are either nontoxic or used in such small quantities that a spill would not result in measurable impacts. Zinc bromide is of particular concern because of the toxic nature of zinc. Close to the release point of an ammonium chloride spill, the ammonia concentrations could exceed toxic levels for time scales of hours to days.

Accidental Releases of Drilling Fluids

As a result of the specific gravity of SBF, an accidental release of synthetic-based drilling fluids would be expected to sink to the seafloor in the area immediately at and adjacent to the release site. Localized anoxic conditions at the seafloor would be expected to occur. This would be short term, lasting until the SBF decomposed.

Collisions

A collision may result in the spillage of crude oil, refined products such as diesel, or chemicals. Diesel is the type of refined hydrocarbon spilled most frequently as the result of a collision. Minimal impacts result from a spill since diesel is light and will evaporate and biodegrade within a few days. Since collisions occur infrequently, the potential impacts to marine water quality are not expected to be significant.

Loss of Well Control

A loss of well control includes events with no surface expression or impact on water quality to events with a release of oil or drilling fluids. A LWC event may result in localized suspension of sediments, thus affecting water quality temporarily. Results from a recent simulated experiment of a deepwater blowout indicated that the oil rose from 850 m to the surface in approximately one hour.

Since LWC events and blowouts are rare events and of short duration, potential impacts to marine water quality are not expected to be significant.

Summary and Conclusion

Smaller spills (<1,000 bbl) are not expected to significantly impact water quality in marine and coastal waters. Larger spills, however, could impact water quality especially in coastal waters. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary localized impacts on water quality.

4.4.3. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by oil spills and cleanup response activities resulting from the proposed actions are considered in **Chapters 4.4.3.1, 4.4.3.2, and 4.4.3.3**. Potential impacts from oil spills to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The types and sources of spills that may occur, their dissipation prior to contacting coastal resources, spill-response activities, and mitigation are described in **Chapter 4.3**.

4.4.3.1. Coastal Barrier Beaches and Associated Dunes

The level of impacts from oil spills depends on many factors, including the type, rate, and volume of oil spilled and the weather and oceanographic conditions at the time of the spill, geographic location and season, and oil-spill response and cleanup preparedness. These parameters would determine the quantity of oil that is dispersed in the water column; the degree of weathering, evaporation, and dispersion of the oil before it contacts a shoreline; the actual amount, concentration, and composition of the oil at the time of the shoreline contact; and a measure of the toxicity of the oil. These factors would determine whether that oil spill will cause heavy long-lasting biological damage, comparatively little damage or no damage, or some intermediate degree of damage. **Chapter 4.3.1** provides estimates of the number of oil spills that might result from a proposed action, as well as oil slick dispersal and weathering characteristics. **Figures 4-13 and 4-14** provide the probability of an offshore spill ≥1,000 bbl occurring and contacting counties and parishes around the Gulf.

In coastal Louisiana, dune-line heights range from 0.5 to 1.3 m above mean high-tide level. In Mississippi and Alabama (coastal Subarea MA-1), dune elevations exceed those in Louisiana. For tides to carry oil from a spill across and over the dunes, strong southerly winds would have to persist for an extended time prior to or immediately after the spill. Strong winds required to produce such high tides would also accelerate dispersal and spreading of the oil slick, thereby reducing impact severity at the landfall site. Significant dune contact by a spill associated with a proposed action is very unlikely. A study in Texas showed that oil disposal on sand and vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

Oil-spill cleanup operations can affect barrier beach stability. If large quantities of sand were to be removed during spill-cleanup operations, a new beach profile and sand configuration would be established in response to the reduced sand supply and volume. The net result of these changes could be accelerated rates of shoreline erosion, especially in a sand-starved, eroding-barrier setting such as found along the Louisiana Gulf Coast. To address these possible impacts, the Gulf Coast States have established policies to limit sand removal by cleanup operations.

Based on MMS analysis of the USCG data on all U.S. coastal spills (**Chapter 4.3.1.7**), MMS assumes that 42 percent of coastal spills that will occur as a result of a proposed action will occur in State offshore waters, 1.5 percent will occur in Federal offshore waters, and 57 percent will occur in inland waters. It is assumed all offshore coastal spills will contact land and proximate resources. Most inshore spills resulting from a proposed action will occur from barge, pipeline, and storage tank accidents involving transfer operations, leaks, and pipeline breaks, which are remote from barrier beaches. When transporting cargoes to terminals, oil barges make extensive use of interior waterways. These interior waterways are remote from barrier beaches; therefore, most inshore spills are assumed to have no contact with barrier beaches or dunes.

For a barge or pipeline accident in State or Federal offshore waters to affect a barrier beach, the accident would need to occur on a barrier beach or dune, or in the vicinity of a tidal inlet.

The September 1989 spill from a barge in the Mississippi Sound oiled the landward side of Horn Island, but not the Gulf side. Similarly, the October 1992 Greenhill Petroleum Corporation oil spill (blowout during production in State waters) just inland of East Timbalier Island, Louisiana, oiled inland shorelines but did not impact barrier beaches or dunes. Other smaller inland oil spills have impacted coastal islands similarly. Inshore pipelines or barge accidents are assumed to result in spilled oil contacting the inland shores of a barrier island, with unlikely adverse impacts to barrier beaches or dunes.

Oil that makes it to the beach may be either liquid weathered oil, an oil and water mousse, or tarballs. Oil is generally deposited on beaches in lines defined by wave action at the time of landfall. Initially, components of oil on the beach will evaporate more quickly under warmer conditions. Under high tide and storm conditions, oil may return to the Gulf and be carried higher onto the beach. Oil that remains on the beach will thicken as its volatile components are lost. Thickened oil may form tarballs or aggregations that incorporate sand, shell, and other materials into its mass. Tar may be buried to varying depths under the sand. On warm days, both exposed and buried tarballs may liquefy and ooze. Oozing may also serve to expand the size of a mass as it incorporates beach materials.

Oil on the beach may be cleaned up manually, mechanically, or by using both methods. Removal of sand during cleanup is expected to be minimized to avoid significantly reducing sand volumes. Some oil will likely remain on the beach at varying depths and may persist for several years as it slowly biodegrades and volatilizes.

Proposed Action Analysis

The probabilities of proposed-action-related spills occurring in OCS waters and contacting various parishes and counties are provided in **Chapter 4.3.1**. The risk of offshore spills ≥1,000 bbl occurring and contacting barrier beaches within 10 days is discussed in **Chapter 4.3.1.8**. Generally, the coastal, deltaic parishes of Louisiana have the highest risk of being contacted by an offshore spill resulting from a proposed action in the CPA; Plaquemines Parish has the highest probability at 10-15 percent. The probabilities of an offshore spill occurring and contacting coastal counties or parishes as a result of a proposed action in the WPA are generally higher for the region between Matagorda County, Texas, and Cameron Parish, Louisiana.

Coastal spills in offshore coastal waters or in the vicinity of Gulf tidal inlets present a greater potential risk to barrier beaches because of their close proximity. Inland spills that occur away from Gulf tidal inlets are generally not expected to significantly impact barrier beaches and dunes.

Summary and Conclusion

Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action.

4.4.3.2. Wetlands

The Texas Gulf Coast is comprised of a broad range of saline, brackish, intermediate and fresh marsh wetlands, including wet prairies, forested wetlands, barrier islands, mud flats, estuarine bays, bayous, and riparian wooded areas. Saline and brackish marshes are most widely distributed south of the Galveston Bay area, while the intermediate marshes are the most extensive marsh type east of Galveston Bay. The most extensive wetlands along the Texas coast are located in the Strandplain-Chenier Plain System that runs from eastern Chambers County, Texas, through Vermilion Parish, Louisiana. Coastal Louisiana is made up of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the Chenier Plain extending from eastern Texas through Vermilion Parish, Louisiana; both are influenced by the Mississippi River. Like Texas, the Louisiana wetlands are comprised of a broad range of wetland habitat including saline, brackish, intermediate, and fresh marsh wetlands; barrier islands; cheniers (ancient beach deposits left stranded in a marsh by the seaward advancement of the marsh); mud flats; estuarine bays; and bayous.

Offshore oil spills associated with a proposed action can result from platform accidents, pipeline breaks, or navigation accidents. Offshore spills are much less likely to have a deleterious effect on vegetated coastal wetlands or seagrasses than inshore spills. Information on oil spills related to a proposed action and their risk of occurring is provided in **Chapter 4.3.1**.

Coastal oil spills can result from storage, barge, or pipeline accidents. Most of these occur as a result of transfer operations. As discussed in **Chapter 4.1.3.4.4.6,** approximately 57 percent of coastal spills occur inland.

The most likely locations of coastal spills are at pipeline terminals and other shore bases. Spills from support vessels could occur from navigation accidents and will be largely confined in navigation channels and canals. Slicks may quickly spread through the channel by tidal, wind, and traffic (vessel) currents. Spills that damage wetland vegetation fringing and protecting canal banks will accelerate erosion of those once protected wetlands and spoil banks (Alexander and Webb, 1987).

Primary Impacts of Oil Spills

Shoreline types have been rated (via Environmental Sensitivity Indices, (ESI's); Hayes et al., 1980; Irvine, 2000) according to their expected retention of oil and, to some extent, biological effects are believed to be aligned with oil persistence. This is evident in various low-energy environments like salt marshes. Oil has been found or estimated to persist for at least 17-20 years in such environments (Teal et al., 1992; Baker et al., 1993; Burns et al., 1993; Irvine, 2000). In some instances, where there has been further damage due to cleanup activities, recovery has been estimated to take from 8 to 100 years (Baca et al., 1987). Effects on marsh vegetation can be severe (Baca et al., 1987; Baker et al., 1993). The side effect of the depletion of marsh vegetation, which is of special concern to coastal Louisiana and parts of coastal Texas, is the increased erosion. Again, cleanup activities in marshes may accelerate rates of erosion and retard recovery rates, which have been reported to require from years to decades following a spill.

The critical concentration of oil is that concentration above which impacts to wetlands will be long term and recovery will take longer than two growing seasons, and which causes plant mortality and some permanent wetland loss. Critical concentrations of various oils are currently unknown and are expected to vary broadly for wetland types and wetland plant species. Louisiana wetlands are assumed to be more sensitive to oil contact than elsewhere in the Gulf because of high cumulative stress.

Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting limited areas of wetland habitats (Fischel et al., 1989). Based on data from Mendelssohn et al. (1990), recovered vegetation is expected to be the ecologically functional equivalent of unaffected vegetation. A reduction in plant density was therefore studied as the principle impact from spills. Mendelssohn and his associates demonstrated that oil could persist in the soil for greater than 5 years if a pipeline spill occurs within the interior of a wetland where wave-induced or tidal flushing is not regular or vigorous.

Numerous investigators have studied the immediate impacts of oil spills on wetland habitats in the Gulf and other wetland habitats similar to those affected by OCS activities, resulting in a range of conclusions. Some of these inconsistencies can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, types of vegetation affected, season of year, preexisting stress level of the vegetation, soil types, and numerous other factors. In overview, the data suggest that light-oiling impacts will cause plant dieback with recovery within two growing seasons without artificial replanting. Most impacts to vegetation are considered short term and reversible (Webb et al., 1985; Alexander and Webb, 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989). Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting areas of wetland habitats (Fischel et al., 1989) or open waters. The fluid nature of the oil, water levels, weather, and the density of the vegetation would limit the area of interior wetlands contacted by any given spill.

In coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be 0.1 liter per square meter (l/m^2). Concentrations less than this will cause dieback of the aboveground vegetation for one growing season, but limited mortality. Higher concentrations will cause mortality of contacted vegetation, but 35 percent of the affected area will recover within 4 years. Oil will persist in the wetland soil for at least 5 years. After 10 years, permanent loss of 10 percent of the affected wetland area will be expected as a result of accelerated landloss indirectly caused by the spill. If a spill contacts wetlands exposed to wave attack, additional and accelerated erosion will occur, as documented by Alexander and Webb (1987).

Wetlands in Texas occur on a more stable substrate and receive more inorganic sediment per unit of wetland area than wetlands in Louisiana. Texas wetlands have not experienced the extensive alterations caused by rapid submergence rates and extensive canal dredging that affect Louisiana wetlands. The examinations of Webb and colleagues (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1985) are used to evaluate impacts of spills in these settings. For wetlands along more stable coasts, such as in Texas, the critical oil concentration is assumed to be 1.0 l/m^2 (Alexander and Webb, 1983). Concentrations below the expected 1.0 l/m^2 will result in short-term, above-ground dieback for one growing season. Concentrations above this will result in longer-term impacts to wetland vegetation, including plant mortality extensive enough to require recolonization.

Using these studies, the following model was developed. For every 50 bbl of oil spilled and contacting wetlands, approximately 2.7 ha (6.7 ac) of wetland vegetation will experience dieback. Thirty percent of these damaged wetlands are assumed to recover within 4 years; 85 percent within 10 years. About 15 percent of the contacted wetlands are expected to be converted permanently to open-water habitat.

Secondary Impacts of Oil Spills

The cleanup of oil spills in coastal marshes remains a problematic issue because wetlands can be extremely sensitive to the disturbances associated with cleanup activities. Once a marsh is impacted by an oil spill, a decision must be made concerning the best method of cleanup and restoration. Often the best course of action is to let the impacted area(s) recover naturally in order to avoid secondary impacts associated with the cleanup process (McCauley and Harrel, 1981; Long and Vandermeulen, 1983: Getter et al., 1984; Baker et al., 1993; Mendelssohn et al., 1993). Foot traffic and equipment traffic on the marsh surface during cleanup operations are considered secondary impacts that can have significant adverse effects on the recovery of the marsh by trampling vegetation, accelerating erosion, and burying oil into anaerobic soils where it may persist for years (Getter et al., 1984).

Proposed Action Analysis

Figure 4-13 provides the results of the OSRA model that calculated the probability of a spill ≥1,000 bbl occurring offshore as a result of a proposed action and reaching a Gulf Coast county or parish. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Six counties in Texas and eight parishes in Louisiana have a chance of spill contact that is greater than 0.5 percent. For these counties and parishes, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline ranges from 1 to 15 percent. Plaquemines Parish, Louisiana, has the greatest risk of a spill occurring and contacting its shoreline as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk of being contacted by a spill occurring offshore as a result of a WPA proposed action. Should such a contact occur, oiling will be very light and spotty with short-term impacts to vegetation. Coastal spills are the greater spill threat to interior wetlands.

Summary and Conclusion

Offshore oil spills resulting from a proposed action are not expected to damage significantly any wetlands along the Gulf Coast. However, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in Galveston County and Matagorda County, Texas, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes, Louisiana in the CPA.

Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment and personnel used to clean up a slick over the impacted area may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. Overall, impacts to wetland habitats from an oil spill associated with activities related to a proposed action would be expected to be low and temporary.

4.4.3.3. Seagrass Communities

Seagrass communities in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass beds are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Seagrass beds in the CPA are restricted to small shallow areas behind barrier islands in Mississippi and Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity seagrass beds are found inland and discontinuously throughout the coastal zone of Louisiana and Mississippi.

Accidental impacts associated with a proposed action that could adversely affect seagrass beds include oil spills associated with the transport and storage of oil (**Chapter 4.3.1**). The degree of impact from oil spills depends on the location of the spill, oil slick characteristics, water depth, currents, and weather. Offshore oil spills that occur in the proposed action areas are much less likely to contact seagrass communities than are inshore spills because the seagrass beds are generally protected by barrier islands, peninsulas, sand spits, and currents.

Some oils can emulsify; suspended particles in the water column will adsorb oil in a slick, decreasing the oil's suspendability and causing some of the oil to be dispersed downward into the water column. Typically, seagrass communities reduce water velocity among the vegetation as well as for a short distance above it. Minute oil droplets, whether or not they are bound to suspended particulate, may adhere to the vegetation or other marine life, be ingested by animals, or settle onto bottom sediments. In all of these situations, oil has a limited life because it will be degraded chemically and biologically. Microbes, which are found in all marine environments, are considered the greatest degraders of oil (Zieman et al., 1984). Because estuaries have a greater suspended particulate load and greater microbial population, oil degrades more rapidly there (Lee, 1977). Oil that penetrates deeply into the sediments is less available for dissolution, oxidation, or microbial degradation. If buried, oil may be detectable in the sediments for 5 years or more, depending upon the circumstances.

The cleanup of slicks in shallow or protected waters (less than 5 ft deep) may be performed using johnboats or booms, anchors, and skimmers mounted on boats or shore vehicles. Activities over seagrass beds should be closely monitored to avoid digging into the bed. Wheeled or treaded vehicles should be prohibited. Cleanup methods using other vehicles that dig into the water bottom of the bed (e.g., boat anchors, boat bottoms, props, and booms that require water depths greater than that available over the bed) should not be used. Vehicles and equipment that require minimum water depths of about 6-10 in should be used instead. Personnel assisting in oil-spill cleanup in water shallower than 3-4 ft may readily wade through the water to complete their tasks (**Chapter 4.3.5**), but wading in seagrass beds is to be minimized. Repeated wading in a single path can cause significant damage.

Proposed Action Analysis

The probability of one or more oil spills ≥1,000 bbl occurring due to a proposed action ranges from 31 to 46 percent in the WPA, and from 69 to 86 percent in the CPA. The probabilities of a spill ≥1,000 bbl occurring and contacting environmental features are described in **Chapter 4.3.1.8**. The total estimated number of spill events over the 40-year life of a proposed action is 836-1,465 offshore spills for a typical proposed action in the WPA, and 2,682-4,467 offshore spills for a typical proposed action in the CPA (**Chapters 4.3.1.5 and 4.3.1.6**). Spills that could occur in coastal waters from proposed action support operations are estimated at 15-34 spills for a proposed action in the WPA, and 46-102 spills for a proposed action in the CPA.

The risk of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was calculated by MMS's oil-spill trajectory model. Counties and parishes are used as an indicator of the risk of an offshore spill reaching sensitive coastal environments. **Figures 4-13 and 4-14** provides the results of the OSRA model that calculated the probability of a spill ≥1, 000 bbl occurring offshore as a result of a proposed action in the CPA or WPA and reaching a Gulf Coast county or parish. The probabilities are very small. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Six counties in Texas and eight parishes in Louisiana have a chance of spill contact that is greater than 0.5 percent. For these counties and parishes, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline ranges from 1 percent to 15 percent. Plaquemines Parish, Louisiana, has the greatest risk of a spill occurring and contacting its shoreline. In Texas, Matagorda County has the greatest risk of being contacted by a spill occurring offshore as a result of a WPA proposed action.

Inland seagrass beds are generally protected from offshore spills by barrier islands, shoals, shorelines, and currents. These beds are generally more susceptible to contact by inshore spills, which have a low probability of occurrence. Inshore vessel collisions may release fuel and lubricant oils and pipeline ruptures may release crude and condensate oil. The Galveston/Houston/Texas City area has the greatest risk of experiencing coastal spills related to a proposed action in the WPA, and the Deltaic Plain area of Louisiana has the highest risk from a proposed action in the CPA (**Chapter 4.3.1**). In this region of the Gulf, seagrass beds remain submerged due to the micro-tides that occur there. During calm weather, oil on the sea surface would not contact most seagrass directly. Rough weather can produce increased mixing that would bring oil below the surface and result in oil contacting seagrass communities directly. Their regenerative roots and rhizomes are buried in the water bottom, where they are further protected (**Chapter 3.2.1.3**). Should an oil slick pass over these seagrass communities, damage would occur if an unusually low tide were to occur, causing contact between the two. A more damaging scenario would be that a slick might pass over and remain over a submerged bed of vegetation in a protected embayment during typical fair-weather conditions. This would reduce light levels in the bed. If light reduction continues for several days, chlorophyll content in the leaves will be reduced (Wolfe et al., 1988), causing the grasses to yellow and reducing their productivity. Shading by an oil slick of the sizes described should not last long enough to cause mortality, depending upon the slick thickness, currents, weather, and the nature of the embayment. In addition, a slick that remains over seagrass beds in an embayment also will reduce or eliminate oxygen exchange between the air and the water of the embayment. Oxygen depletion is a serious problem for seagrasses (Wolfe et al., 1988). If currents flush little oxygenated water between the embayment and the larger waterbody and if the biochemical oxygen demand (BOD) is high, as it would be in a shallow water bed of vegetation, and then enhanced by an additional burden of oil, the grasses and related epifauna will be stressed and perhaps suffocated. In this situation, the degree of suffocation will depend upon the reduced oxygen concentration and duration of those conditions. Oxygen concentrations and their duration depend upon currents, tides, weather, temperature, percentage of slick coverage, and BOD.

Should weather conditions or currents increase water turbulence sufficiently, a substantial amount of oil from the surface slick will be dispersed downward into the water column. There it will adsorb to suspended particles in the water column, becoming less buoyant. Submerged vegetation reduces water velocity, promoting sedimentaion among the vegetation. Typically, this oily sedimentation will not cause long-term or permanent damage to the seagrass communities. Some dieback of leaves would be expected for one growing season. In a severe case where high concentrations of hydrocarbons are mixed into the water column, the diversity or population of epifauna and benthic fauna found in seagrass beds could be impacted. Seagrass epiphytes are sessile plants and animals that grow attached to their seagrass host; they play an important role in the highly productive seagrass ecosystem. The small animals, such as amphipods, limpets and snails, would likely show more lethal effects than the epiphytic plant species. The lack of grazers could lead to a short-term (up to 2 years) imbalance in the seagrass epifaunal community and cause stress to the seagrass as a result epiphyte overgrowth. No permanent loss of seagrass habitat is projected to result from the spill unless an unusually low tidal event allows direct contact between the slick and the vegetation.

No significant burial of the oil is expected to occur from any one spill. Oil measured at some depth usually means the area is impacted by chronic oil contamination, new sediments are spread over the area, or heavy foot or other traffic works the oil into the bottom sediment. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. As mandated by OPA 90, seagrass beds and live-bottom communities are expected to receive individual consideration during spill cleanup.

Summary and Conclusion

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities with the highest probabilities of contact within 10 days would be those located within Matagorda County, Texas, for a proposed action in the WPA and Plaquemines Parish, Louisiana, for a proposed action in the CPA.

Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Although the probability of their occurrence is low, the greatest threat to inland, seagrass communities would be from an inland spill resulting from a vessel accident or pipeline rupture. Although a resulting slick may cause minor impacts to the bed, equipment and personnel used to clean up a slick over shallow seagrass beds may generate the greatest direct impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

4.4.4. Impacts on Sensitive Offshore Benthic Resources

4.4.4.1. Continental Shelf Benthic Resources

4.4.4.1.1. Live Bottoms (Pinnacle Trend)

A number of OCS-related factors may cause adverse impacts on the pinnacle trend communities and features. Damage caused by oil spills, blowouts, anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, produced-water discharges, and the disposal of domestic and sanitary wastes can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

Oil spills have the potential to foul benthic communities and cause lethal or sublethal effects on live-bottom organisms. Oil from a surface spill can be driven into the water column, with measurable amounts documented to a 10-m (33 ft) depth. Modeling exercises have indicated such oil may reach a depth of 20 m (66 ft). Yet, at this depth, the spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981). Subsurface oil spills from pipeline ruptures would have a greater potential to bring high concentrations of oil in contact with the biota of the pinnacles. The actual concentrations of subsurface-released oil reaching this biota would depend on the severity and the proximity of the spill and on the speed and direction of prevailing subsurface currents.

Blowouts have the potential of resuspending considerable amounts of sediment and releasing hydrocarbons into the water column. This would pose a threat to the biota of pinnacles, particularly when the disturbance is immediately adjacent to the resource. Oil or condensate may be present in the reservoir and may also be injected into the water column. The bulk of the sediments would be redeposited within a few thousand meters (yards) of the blowout site. The sedimentation caused by a severe subsurface blowout occurring within 400 m (1,312 ft) of a pinnacle community could result in the smothering of biota. Blowout incidents do not necessarily result in sediment releases or resuspension.

Proposed Action Analysis

The pinnacles in the Central GOM are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama within offshore Subareas C0-60 and C60-200; there are no known pinnacle features found in the Western Gulf. **Table 4-3** provides information regarding the level of OCS-related activities in the vicinity of the pinnacles including the number of projected wells, production structures, pipeline lengths, and blowouts. The majority of the exploratory/delineation wells and production structures will not be located in the pinnacle trend area, based on an MMS analysis.

Any surface oil spill resulting from a proposed action would likely have no impact on the biota of the pinnacle trend because the crests of these features are much deeper than 20 m (66 ft).

All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (**Chapter 4.3.1.5.4**), making them unlikely to affect pinnacles. If a pipeline leak were close to a pinnacle with a strong bottom current at the time of the spill, oil could contact the pinnacle. This is unlikely since regulations generally require pipelines to avoid pinnacles by at least 100 ft (30 m). The risk for weathering components from a surface slick reaching pinnacles in any measurable concentrations would be very small. Such natural containment and dispersion of oil, as well as the widespread nature of the biota, would limit the severity and the extent of the area impacted by subsurface spills. A subsurface pipeline oil spill (≥1,000 bbl) could result in the most deleterious impacts on the biota of pinnacles, particularly if the oil impinges directly on the pinnacles. Yet, the biota of the pinnacles would probably recover once the oil is cleared. There are no data to date that reveal the effects or recovery time associated with oil spills on pinnacle trend features.

There are 2-3 projected blowouts associated with a proposed action in the CPA (**Table 4-3**); however, any activity of a debilitating nature would be well away from the pinnacles based on the implementation of the proposed Live Bottom Stipulation, which restricts the distance wells can be from a pinnacle feature. The pinnacles are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama.

Summary and Conclusion

There would be few operations in the vicinity of the pinnacles as a result of a proposed action and these would be restricted by the Live Bottom (Pinnacle Trend) Stipulation. Because of this and the small size and dispersed nature of many of the features, impacts from accidental events as a result of a proposed action are expected to be infrequent. No community-wide impacts are expected. Potential impacts from blowouts would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. Oil spills would not be followed by adverse impacts (e.g., elevated decrease in live cover) because of the depth of the features and dilution of spills (by currents and the quickly rising oil). The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features.

Effects of the Proposed Action without the Proposed Stipulation

Activities resulting from a proposed action without the protection of the proposed biological stipulation could have an extremely deleterious impact on portions of the pinnacle trend. Potential impacts of accidental events, including oil spills and blowouts, on the pinnacle trend areas from a proposed action would be infrequent because of the low projected levels of OCS activities. In addition, the widespread occurrence of these pinnacles would further restrain these impacts.

4.4.4.1.2. Topographic Features

The topographic features of the Western and Central Gulf sustaining sensitive offshore habitats are listed and described in **Chapters 4.2.1.1.4.1.1 and 4.2.2.1.4.1.2**, respectively. Please refer to **Chapters**

2.3.1.3.1 and 2.4.1.3.1 for a complete description and discussion of the proposed Topographic Features Stipulations.

Disturbances resulting from the proposed actions, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features of both the WPA and CPA.

Oil spills potentially affecting topographic features and their biological communities could result from surface and seafloor spills. Surface oil spills may occur as a result of platform or tanker spills. A tanker accident, pipeline rupture, or well blowout could cause spills at the seafloor. Both surface and subsurface spills could result in a steady discharge of oil over a long period of time. The depth to which topographic features rise in the northern Gulf of Mexico (to within 15 m [49 ft] of the sea surface) and their distance from shore (more than 103 km (64 mi)) should protect any of the tropical reef plant and animal species they harbor from surface oil slicks. Oil from a surface spill can be driven into the water column; measurable amounts have been documented down to a 10-m (33-ft) depth, although modeling exercises have indicated such oil may reach a depth of 20 m (66 ft). At this depth, the oil is found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). Because the crests of topographic features in the northern Gulf are found below 10 m (33 ft), no concentrated oil from a surface spill could reach their sessile biota.

A subsurface oil spill could reach a topographic feature and would have the potential of considerably impacting the local biota contacted by the oil. Such impacts on the biota may have severe and long-lasting consequences, including loss of habitat, biodiversity, and live coverage; destruction of hard substrate; change in sediment characteristics; and reduction or loss of one or more commercial and recreational fishery habitats.

Subsurface spills could result in the formation and settling of oil-saturated material, and oil-sediment particles could come into contact with living coral tissue; however, a subsurface spill should rise to the surface, and any oil remaining at depth would probably be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Should any of the oil come in contact with adult sessile biota, effects would be primarily sublethal, with few incidences of actual coral mortality. The sublethal effects could be long lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature and diseases) (Jackson et al., 1989).

Continental Shelf Associates (CSA) (1992b) modeled the potential impacts of a pipeline larger than the one estimated to occur from a proposed action (10,000 bbl spilled over 2-7 days) to maximize the estimates of dispersed oil concentrations reaching four topographic features (East Flower Garden, West Flower Garden, MacNeil, and Rankin Banks). Referencing their model, CSA estimated that the worst-case concentrations of crude oil reaching the four banks would be sublethal to the corals and much of the other biota present.

CSA (1994) also investigated the potential effects of oil spilled from a platform-pipeline complex proposed for installation near the Flower Garden Banks using a range of spill scenarios that included the most likely one estimated for this EIS. Twenty-four different spill scenarios from two platforms and three pipelines were modeled. The modeling analyzed the maximum concentration of oil reaching the East Flower Garden Bank. The most damaging scenarios resulting from this modeling effort included a 2,617-bbl/day and a 1,000-bbl/day spill, both lasting 30 days and both occurring at the same platform location. Although the model estimated no acute toxicity to reef coral colonies, the values were within the range of acute toxicity to embryos and larvae of fish, corals, and other invertebrates.

In 1996, the Regional Response Team for Region VI, which includes the coastal states of Texas and Louisiana, approved the use of chemical dispersants on surface oil spills in exclusion zones of the northern Gulf such as the Flower Garden Bank National Marine Sanctuary (revised Federal On-Scene Coordinator Preapproved Dispersant Use Manual-Region VI Oil and Hazardous Substances Pollution Contingency Plan). Depending on the toxicity of the dispersant used; tradeoffs to responding to surface oil spills using dispersants include impacts on pelagic organisms and on the adult as well as the larval stages of benthic organisms on topographic features. Gulf of Mexico oil, however, is usually dispersed with Corexit 9527. Considering the depth of the crests of topographic features (greater than 15 m (49 ft)), the dilution by seawater, and the added dispersion by currents, any dispersed oil that reaches the benthic dwellers would be expected to be at very low concentrations (less than 1 ppm). Such low oil concentrations would not be life threatening to larval or adult stages at depth (Fucik et al., 1994).

Dispersants would probably not be approved during coral spawning periods (e.g., August-September for major reef-building species) (Gittings et al., 1992 and 1994) in order to limit the impacts of oil pollution on the near-surface portion of the water column.

Dodge et al. (1995) observed that, compared to a control site and to a site exposed to oil alone, a 2-m (7-ft) deep reef environment off the Caribbean coast of Panama was negatively impacted by dispersed oil (probably at a concentration greater than 10 ppm) as it reduced the cover of all reef organisms as much as 40 percent, particularly that of live substrate-binding sponges. Ten years later, the same impacted site regained or even exceeded the pre-impact live cover. Guzman et al. (1991), however, found that a prolonged exposure to oil alone, as well as chronic exposure to oil, greatly depressed both the coverage and growth rates of reef corals within a 6-m (20-ft) -deep reef area along the Caribbean coast of Panama. Also, Bak (1987) showed that reef corals on the shallow (4-6 m) southwestern shore of Aruba (Netherlands Antilles) had incurred mortality, decreases in live coral cover by as much as 70 percent, reductions of species diversity (as many as 10 out of 24 species missing), and reef structural changes over a 10- to 15-km (6-9 mi) downstream shore length as a result of the exposure to long-term (1929-1985) chronic oil spills, dispersed oil, and refinery discharges. *Diploria strigosa* appeared to be more resilient to oil pollution than other reef coral species because its cover did not seem to be affected by the pollutants. Therefore, it has been shown that oil, as well as dispersed oil, has the potential to greatly impact reef coral communities, particularly when the exposure is chronic and long term. The time needed for the recovery of such impacted reefs could be as long as 30 years and would depend on the frequency and severity of any future human-made and natural disturbances.

The proposed Topographic Features Stipulations would preclude drilling within 152 m (500 ft) of a No Activity Zone to prevent adverse effects from nearby drilling on topographic features. Oil spills originating outside the No Activity Zones would rise to the surface and be dispersed to diluted concentrations in the water column prior to reaching topographic features (CSA, 1992b and 1994).

Oil or gas well blowouts are possible occurrences in the OCS. Benthic communities exposed to large amounts of resuspended sediments following a subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light. Should oil or condensate be present in the blowout flow, liquid hydrocarbons could be an added source of negative impact on the benthic community (low-molecular-weight gases would dissolve in the water column until saturation is reached). The amounts of oil or sediments that settle vary as a function of the specific gravity of the oil or the sediments, and their dilution, dispersion, and response to currents (Brooks and Bernard, 1977). In most cases, currents should sweep the impact-producing materials around a topographic feature rather than deposit them on top of it (Rezak et al., 1983). The bulk of the blowout materials would be redeposited within a few thousand meters (yards) of their source; sand would be redeposited within 400 m (1,312 ft) of the blowout site. The extent of the damage incurred by the benthic community would depend on the amount and duration of exposure to sediments or oil. The consequences of a blowout directly on or near a topographic feature could last more than 10 years. Since the proposed stipulations would preclude drilling within 152 m (500 ft) of the No Activity Zone, most adverse effects on topographic features from blowouts would likely be prevented.

Proposed Action Analysis

All of the 37 topographic features (shelf edge banks, mid-shelf banks, and South Texas banks) in the WPA and CPA are found in waters less than 200 m (656 ft) deep. They represent a small fraction of the continental shelf area in the WPA and CPA. The fact that the topographic features are widely dispersed, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to the topographic features.

The proposed Topographic Features Stipulations (discussed in **Chapters 2.3.1.3.1 and 2.4.1.3.1**) will assist in preventing most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of topographic features. However, operations outside the No Activity Zones (including blowouts and oil spills) may still affect topographic features. The projected oil-spill scenarios related to the proposed actions for the WPA and CPA (projections are based on a 40-year life for any one lease sale) are found in **Table 4-35**.

Approximately 1 blowout is projected to occur in waters less than 200 m (656 ft) deep in the WPA and 0 blowouts are projected in the CPA during activities resulting from the proposed actions. With the application of the proposed stipulations, none of these blowouts should occur within the No Activity Zones. Furthermore, blowouts outside the No Activity Zones are unlikely to impact the biota of topographic features.

Some offshore resources are at a minimal risk of being contacted should a spill occur as a result of a proposed action (**Figures 4-15 and 4-16**). There is a 4-7 percent and 2-3 percent likelihood that a spill would occur and reach the area of the Flower Garden Banks National Marine Sanctuary from the WPA and CPA, respectively. The East Flower Garden Bank rises to within 16 m of the sea surface, and the West Flower Garden Bank to within 18 m (59 ft). Any oil that might be driven to 16 m or deeper would probably be at concentrations low enough to avoid or substantially reduce any impact; therefore, a surface oil spill would probably not impact the biota of the Flower Garden Banks or the other topographic features. In addition to the Flower Garden Banks, there are several other feature locations with a minimal percent probability of an accidental oil spill reaching their locations as a result of a proposed action.

A subsurface spill originating from a pipeline rupture or a blowout may cause sessile biota of topographic features to be impacted by oil, potentially causing sublethal and lethal effects. Projections of persistence for a pipeline spill occurring during the summer months 50 mi off Louisiana in 200 ft of water and for a winter spill occurring 65 mi off Texas in 130 ft of water are listed in **Tables 4-36 and 4-37**. The Topographic Features Stipulations would limit the potential impact of such occurrences by keeping the sources of such adverse events geographically removed from the sensitive biological resources of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulations will assist in preventing most of the potential impacts on topographic feature communities from blowouts and surface and subsurface oil spills. Recovery from incidences of impacts from blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulations would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Effects of the Proposed Actions without the Proposed Stipulations

The topographic features and associated coral reef biota of the Western and Central Gulf could be adversely impacted by oil and gas activities resulting from the proposed actions should they be unrestricted by the absence of the proposed Topographic Features Stipulations. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected topographic features.

The area within the No Activity Zones would probably be the areas of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Features Stipulations or project-specific mitigating measures. These impacting factors would include blowouts, surface oil spills, and subsea oil spills. Potential impacts from routine activities resulting from the proposed actions are discussed in **Chapters 4.2.1.1.4.2 and 4.2.2.1.4.2**. Oil spills as well as routine activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Indeed, disturbances, including oil spills and blowouts, would alter benthic substrates and their associated biota over areas possibly ranging from tens to thousands of square meters per event. In the unlikely event of a blowout, sediment resuspension potentially associated with oil could cause adverse turbidity and sedimentation conditions. In addition to affecting the live cover of a topographic feature, a blowout could alter the local benthic morphology, thus irreversibly altering the reef community. Oil spills (surface and subsea) could be harmful to the local biota should the oil have a prolonged or recurrent contact with the organisms.

Therefore, in the absence of the Topographic Features Stipulations, the proposed actions could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.4.4.2. Continental Slope and Deepwater Resources

4.4.4.2.1. Chemosynthetic Deepwater Benthic Communities

Accidental events that could impact chemosynthetic communities are limited primarily to blowouts. A blowout at the seafloor could create a crater and could resuspend and disburse large quantities of bottom sediments within a 300-m (984-ft) radius from the blowout site, thus organisms located within that distance. The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude the impact of a blowout to a distance of at least 457 m (1,500 ft).

Impacts to chemosynthetic communities from any oil released would be a remote possibility. Release of hydrocarbons associated with a blowout should not present a possibility for impact to chemosynthetic communities located a minimum of 457 m (1,500 ft) from well sites. All known reserves in the GOM to date have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. The potential for weathered components from a surface slick reaching a chemosynthetic community in any measurable volume would be very small.

Oil and chemical spills are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (**Chapter 4.3.1.5.4**), and thus not impact the benthos. The risk for weathering components from a surface slick reaching the benthos in any measurable concentrations would be very small.

There is some reason to believe the presence of oil may not have an impact in the first place because these communities live among oil and gas seeps; however, natural seepage is very constant and at very low rates as compared to the potential volume of oil released from a blowout or pipeline rupture. All seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried.

Proposed Action Analysis

For water depths greater than 400 m (1,312 ft), 0-1 blowouts are estimated as the result of the WPA proposed action and 0-3 blowouts are estimated in the CPA proposed action.

The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude any impact from a blowout at a minimum distance of 457 m (1,500 ft), which is beyond the distance of expected benthic disturbance. Resuspended bottom sediments transported by near-bottom currents could reach chemosynthetic communities located beyond 457 m and potentially impact them by burial or smothering.

The risk of various sizes of oil spills occurring as a result of the proposed actions are presented in **Table 4-35**. The probability of oil in any measurable concentration reaching depths of 400 m (1,312 ft) or greater is very small.

Summary and Conclusion

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type). There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried by resuspended sediments from a blowout.

Potential accidental impacts from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities located at more than 1,500 ft away from a blowout could experience minor impacts from resuspended sediments.

4.4.4.2.2. Nonchemosynthetic Deepwater Benthic Communities

A blowout at the seafloor could create a crater and could resuspend and disperse large quantities of bottom sediments within a 300-m radius from the blowout site, thus destroying any organisms located within that distance by burial or modification of narrow habitat quality requirements. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole or even in relation to a small area of the seabed within a lease block.

Oil and chemical spills are not considered to be a potential source of measurable impacts to nonchemosynthetic deepwater benthic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (**Chapter 4.3.1.5.4**), and thus not impact the benthos. The risk for weathering components from a surface slick reaching the benthos in any measurable concentrations would be very small.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be relatively rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate, but adherence to the provisions of NTL 2000-G20 should prevent all but minor impacts to hard-bottom communities beyond 454 m (1,500 ft). Under the current review procedures for chemosynthetic communities, carbonate outcrops (high reflectivity surface anomalies on 3-D seismic survey data) are targeted as one possible indication that chemosynthetic seep communities are present. Any unique nonchemosynthetic communities that may be associated with carbonate outcrops or other topographical features would be avoided via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a potential geological hazard for any well sites. Any proposed impacting activity in water depth greater than 400 m (1,312 ft) would automatically trigger the NTL 2000-G20 evaluation described above.

Proposed Action Analysis

For water depths greater than 400 m (1,312 ft), 0-1 blowouts are estimated as a result of the WPA proposed action and 0-3 blowouts are estimated as a result of the CPA proposed action. Resuspended sediments caused from a blowout will have minimal impacts on the full spectrum of soft-bottom community animals, including the possible mortality of a few megafauna organisms such as a crab or shrimp.

The risk of various sizes of oil spills occurring in the proposed actions are presented in **Table 4-35**. The probability of oil in any measurable concentration reaching depths of 400 m (1,312 ft) or greater is very small.

Summary and Conclusion

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of hours to days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities will likely be avoided as a consequence of the application of NTL 2000-G20 and the similar geophysical signatures (hard bottom) indicating the potential presence of chemosynthetic communities.

Accidental events from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities.

4.4.5. Impacts on Marine Mammals

Accidental, unexpected industrial events associated with the proposed action could impact marine mammals. Such impacts would primarily be the result of blowouts, oil spills, and/or effects associated with the response to an oil spill.

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development including exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise. It is speculated that the burst of sound may harass or injure marine mammals, depending on their proximity to the accident.

Oil Spills

The most toxic components of oil generally evaporate quickly when a spill occurs. For this reason, lethal concentrations of oil with high toxicity leading to large-scale marine life mortality are relatively rare, localized, and short-lived (ITOPF, 2006).

Each major grouping of marine mammals (e.g., manatees and dugongs, and baleen and toothed whales) may be impacted by spilled hydrocarbons in different ways. Oil spills could affect marine mammals through various pathways: surface contact, inhalation, ingestion, and baleen fouling (Geraci, 1990). Much of the information on the effects of oil on marine mammals comes from studies of fur-bearing marine mammals (e.g., seals and sea lions, and sea otters). Sea otters exposed to the *Exxon Valdez* spill experienced high incidences of emphysema, petroleum hydrocarbon toxicosis, abortion, and stillbirths (Williams and Davis, 1995). Direct contact with oil and/or tar for cetaceans (whales and dolphins) can lead to irritation and damage of skin and soft tissues (such as mucous membranes of the eyes), fouling of baleen plates so as to hinder the flow of water and interfere with feeding, and incidental ingestion of oil and/or tar. Studies by Geraci and St. Aubin (1982 and 1985) have shown that the cetacean epidermis functions as an effective barrier to noxious substances found in petroleum. Unlike other mammals, penetration of such substances in cetacean skin is impeded by tight intercellular bridges, the vitality of the superficial cells, the thickness of the epidermis, and the lack of sweat glands and hair follicles (Geraci and St. Aubin, 1985). The cetacean epidermis is nearly impenetrable, even to the highly volatile compounds in oil, and when skin is breached, exposure to these compounds does not impede the progress of healing (Geraci and St. Aubin, 1985). Cetacean skin is free from hair or fur, which in other marine mammals, such as pinnipeds and otters, tends to collect oil and/or tar that subsequently reduces the insulating properties of the fur (Geraci, 1990). Dolphins maintained at a captive site that were exposed to petroleum products initially exhibited a sharp decrease of food intake along with excited behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a decrease of those blood parameters, changes in breathing patterns and gas metabolism, depressed nervous functions, and the appearance of skin injuries and burns (Lukina et al., 1996). Experiments with a harbor porpoise in similar conditions possibly resulted in aspiration pneumonia (Lukina et al., 1996). Marine mammals may also incur eye damage that leads to ulcers, conjunctivitis or blindness. Such injury can result in starvation (AMSA, 2003).

Fresh crude oil or volatile distillates release toxic vapors that, when inhaled, can lead to irritation of respiratory membranes, lung congestion, and pneumonia. Subsequent absorption of volatile hydrocarbons into the bloodstream may accumulate into such tissues as the brain and liver, causing neurological disorders and liver damage (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990). Toxic vapor concentrations just above the water's surface (where cetaceans draw breath) may reach critical levels for the first few hours after a spill, prior to evaporation and dispersion of volatile aromatic hydrocarbons and other light components (Geraci and St. Aubin, 1982). Young marine mammals may be poisoned by the absorption of oil through the mothers' milk (AMSA, 2003).

Trained, captive bottlenose dolphins exposed to oil could not detect light oil sheen but could detect thick dark oil based on visual, tactile, and presumably echolocation cues (Geraci et al., 1983; Smith et al., 1983). Studies of captive dolphins also showed that they completely avoided surfacing in slick oil after a few brief, initial tactile encounters. Reactions of free-ranging cetaceans to spilled oil appear varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive dolphins, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering the slick oil, which could increase their vulnerability to potentially harmful exposure to oil chemicals (Smultea and Würsig, 1991 and 1995). It is possible that some overriding behavioral motivation (such as feeding) induced dolphins to swim through the oil; that slick areas were too large for dolphins to feasibly avoid, or that bottlenose dolphins have become accustomed to oil due to the extent of oil-related activity in the Gulf (Smultea and Würsig, 1995). After the *Exxon Valdez* spill, killer whales did not appear to avoid oil; however, none were observed in heavier slicks of oil (Matkin et al., 1994). It is unknown whether animals in some cases are simply not affected by the presence of oil, or perhaps are even drawn to the area in search of prey organisms attracted to the oil's protective surface shadow (Geraci, 1990). The probable effects on cetaceans swimming through an area of oil would depend on a number of factors, including ease of escape from the vicinity, the health of the individual animal, and its immediate response to stress (Geraci and St. Aubin, 1985).

Spilled oil can lead to the localized reduction, disappearance, or contamination of prey species. Prey species, such as zooplankton, crustaceans, mollusks, and fishes, may become contaminated by direct contact and/or by ingesting oil droplets and tainted food. Marine fishes are known to take up petroleum hydrocarbons from both water and food, though apparently do not accumulate high concentrations of hydrocarbons in tissues, and may transfer them to predators (Neff, 1990). Cetaceans may consume oil-contaminated prey (Geraci, 1990) or incidentally ingest floating or submerged oil or tar. Hydrocarbons may also foul the feeding apparatus of baleen whales (though laboratory studies suggest that such fouling has only transient effects) (Geraci and St. Aubin, 1985). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon, body-burden content is highest for benthic feeding whales and pinnipeds. The potential is reduced for plankton-feeding whales and is lowest for fish-eating whales and pinnipeds (Würsig, 1990). Baleen whales occurring in the GOM are rare and feed on small pelagic fishes (such as herring, mackerel, and pilchard) and cephalopods (Cummings, 1985). An analysis of stomach contents from captured and stranded toothed whales suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). Dolphins feed on fish and/or squid, depending upon the species (Mullin et al., 1991).

As noted by St. Aubin and Lounsbury (1990), there have been no experimental studies and only a handful of observations suggesting that oil have harmed any manatees or dugongs. Dugongs (relatives of the manatees) have been found dead on beaches after the Gulf War oil spill and the 1983 *Nowruz* oil spill caused by the Iran-Iraq War (Preen, 1991; Sadiq and McCain, 1993). Some dugongs were sighted in the oil sheen after the Gulf War (Pellew, 1991). Types of impacts to manatees and dugongs from contact with oil include (1) asphyxiation due to inhalation of hydrocarbons, (2) acute poisoning due to contact with fresh oil, (3) lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum components into body tissues, (4) nutritional stress through damage to food sources, and (5) inflammation or infection and difficulty eating due to oil sticking to the sensory hairs around their mouths (Preen, 1989, in Sadiq and McCain 1993, AMSA, 2003). Manatees concentrate their activities in coastal waters, often resting at or just below the surface, which may bring them in contact with spilled oil (St. Aubin and Lounsbury, 1990). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food; such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980; Reynolds, 1980). Oil spills within the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could endanger local populations. Manatees able to escape such areas might be forced into colder waters, where thermal stress could complicate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990). Such a scenario will expose them to increased vessel traffic, the primary cause of unnatural manatee deaths. For a population whose environment is already under great pressure, even a localized incident could be significant (St. Aubin and Lounsbury, 1990). Spilled oil might affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed. Etkin (1997) reported that dugongs and manatees may develop a type of "lipid pneumonia" from inhaling small droplets of oil when they surface through oiled water to breathe. They may also suffer chronic long-term effects, such as liver problems, from the ingestion of oil or oiled plants. However, as manatees and dugongs have poorly developed pelage, they are less likely to suffer from adherence of oil.

Indirect consequences of oil pollution on marine mammals include those effects that may be associated with changes in the availability or suitability of prey resources (Hansen, 1992). Depending on the spatial scale and magnitude of an oil spill, diminished prey abundance and availability may cause marine mammal predators to move to less suitable areas and/or consume less suitable prey. In either case, the impact can be significant to a marine mammal population or stock. No long-term bioaccumulation of hydrocarbons have been demonstrated; however, an oil spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making them more vulnerable to disease, parasitism, environmental contaminants, and/or predation.

Spill-Response Activities

Spill-response activities include the application of dispersant chemicals to the affected area (**Chapter 4.3.5**). Dispersant chemicals are designed to break oil on the water's surface into minute droplets, which then break down in seawater. Essentially nothing is known about the effects of oil dispersants on cetaceans, except that removing oil from the surface would reduce the risk of contact and render it less likely to adhere to skin, baleen plates, or other body surfaces (Neff, 1990). The acute toxicity of most oil dispersant chemicals is considered to be low relative to the constituents and fractions of crude oil and refined products, and studies have shown that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil (Wells, 1989). Varieties of aquatic organisms readily accumulate and metabolize surfactants from oil dispersants. Enzymatic hydrolysis of the surfactant yields hydrophilic and hydrophobic components. The former probably are excreted via the gills and kidneys, whereas the latter accumulate in the gallbladders of fish and are excreted very slowly (Neff, 1990). Metabolism of surfactants is thought to be rapid enough that there is little likelihood of food chain transfer from marine invertebrates and fish to predators, including marine mammals (Neff, 1990).

Biodegradation is another process used for removing petroleum hydrocarbons from the marine environment, utilizing chemical fertilizers to augment the growth of naturally occurring hydrocarbon-degrading microorganisms. Toxic effects of these fertilizers on cetaceans are presently unknown.

Proposed Action Analysis

Marine mammals occur in the inshore, coastal and oceanic waters of the GOM and could be impacted by accidental spills resulting from operations associated with the proposed actions in the WPA and CPA. The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in **Chapter 4.3.1**. **Table 4-38** lists estimates for spill magnitude and abundance for Gulf coastal waters as a result of a proposed action. Estimates of spill magnitude and abundance for Federal OCS waters as a result of a proposed action are given in **Table 4-35**. **Chapter 4.3.1.8** summarizes MMS's information on the risk to marine mammals analyzed in this EIS from oil spills and oil slicks that could occur as a result of a proposed action in the WPA or CPA. **Figure 4-17** also provides the probabilities of a spill ≥1,000 bbl occurring from a proposed action and the slick reaching identified marine mammal coastal habitats within 10 days.

The greatest diversity and abundance of cetaceans inhabiting the GOM is found in its oceanic and OCS waters. Individual cetaceans are not necessarily randomly distributed in the offshore environment, but are instead prone to forming groups of varying sizes. In some cases, several species may be found aggregating in the same area. Large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased likelihood of impacting cetacean populations inhabiting these waters. Based on abundance estimates and a hypothetical spill surface area, spills occurring in these waters could impact more species and more individuals than coastal spills potentially impacting coastal marine mammals. The endangered sperm whales use oceanic waters as their principle habitat, and the current abundance estimate for the northern Gulf is 1,349 animals (Waring et al., 2006).

The probability of a single marine mammal encountering an oil slick from a single, small spill is extremely low. However, several factors increase the probability of marine mammal/oil-spill contact, including (1) marine mammals often travel long distances in the Gulf, increasing the geographic areas of potential impact; (2) marine mammals are relatively long-lived and have many years during which they may be impacted; (3) the life of the proposed action also means many years for an impact to occur; and (4) some spills will be larger increasing the area of potential impact. Also, considering marine mammal populations instead of individual animals increases the probability of impact in that there are numerous animals and an encounter with an oil slick by any one of them could be considered an impact to the population. However, such impact is not expected to be significant to the population.

It is impossible to know precisely which cetacean species, population, or individuals will be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to predicting when and where oil spills will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with the proposed actions and the distribution of marine mammals in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that the proposed actions in the WPA and CPA may introduce 11,167-31,777 bbl of oil into Gulf marine and estuarine environments over 40 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers. **Chapter 4.3.1.6.4** details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse, cetaceans may be exposed via the waters that they drink and swim in, as well as via the prey they consume. For example, tarballs may be consumed by marine mammals and by other marine organisms that are eaten by marine mammals. Although marine mammals may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of the proposed actions during their lifetimes.

Oil spills have the potential to cause chronic (long-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals. Long-term effects include (1) decreases in prey availability and abundance because of increased mortality rates, (2) change in age-class population structure because certain year-classes were impacted more by oil, (3) decreased reproductive rate, and (4) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in marine mammal behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects.

During a blowout, the pressure waves and noise generated by the eruption of gases and fluids might be significant enough to harass or injure marine mammals, depending on the proximity of the animal to the blowout. There are 1-2 blowouts projected to occur from a proposed lease sale in the WPA (**Table 4-2**) and 2-3 blowouts projected from a proposed lease sale in the CPA (**Table 4-3)**. The effects of explosions and noise on marine mammals are discussed at length in **Chapters 4.2.1.5. and 4.2.2.1.5**.

Blowouts, oil spills, and spill-response activities have the potential to adversely affect marine mammals, causing physical injury and irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. If these accidental events occur within marine mammal habitat, impacts will likely follow as animals are exposed to pollutants. Some short-term (0-1 month) effects of an accidental oil event on marine mammal assemblages may be (1) changes in species or social group distributions due to avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance, (2) increased mortality rates from ingestion or inhalation of oil, and (3) impaired health (Harvey and Dahlheim, 1994). Causes of long-term effects may include (1) initial sublethal exposure to oil causing pathological damage, (2) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey, and (3) diminished availability of prey as a result of the spill (Ballachey et al., 1994). While no conclusive evidence of an impact on whales and dolphins by the *Exxon Valdez* spill was uncovered (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994; Loughlin, 1994), investigations on the effects on sea otters and harbor seals revealed pathological effects on the liver, kidney, brain (also evidenced by abnormal behavior), and lungs, as well as gastric erosions (Ballachey et al., 1994; Lipscomb et al., 1994a; Lowry et al., 1994; Spraker et al., 1994). In addition, harbor seal pup production and survival appeared to be affected (Frost et al., 1994). A delayed effect of oil spills on river otters was strongly suggested in Bowyer et al. (1994). Studies of sea otters in western Prince William Sound in 1996-1998 indicate continued exposure to residual *Exxon Valdez* oil (Ballachey et al., 1999; Monson et al., 2000).

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the GOM. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents, characteristics of spilled oil, spill-response capabilities and timing, and various meteorological and hydrological factors. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in harassment, harm, or mortality to marine mammals occurring in the northern Gulf. Marine mammals made no apparent attempt to avoid spilled oil in some cases (e.g., Smultea and Würsig, 1995); however, marine mammals have been observed apparently detecting and avoiding slicks in other reports (e.g., Geraci and St. Aubin, 1987). Exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick is likely to result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to marine mammals.

4.4.6. Impacts on Sea Turtles

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident.

Oil Spills

In recent years, increased regulation and decreased tolerance of potentially harmful experimentation with endangered species has limited the available data on adverse impacts from events such as oil spills. Much of the best available science about the physiological response of sea turtles (and marine mammals) to oil exposure comes from studies and observations done in the 1990's and earlier. Also, decreasing oil spill occurrence due to increased safety and security requirements for petroleum transport limits the number of field observations of the effects of spilled oil on sea turtles and other marine fauna.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location; hydrocarbon type, dosage, and weathering; impact area; oceanographic and meteorological conditions; season; and life history stages of animals exposed to the hydrocarbons (NRC, 2003). All sea turtle species and life stages are vulnerable to the harmful effects of oil through direct contact or by fouling of their habitats and prey. Van Vleet and Pauly (1987) suggested that discharges of crude oil from tankers were having a significant effect on sea turtles in the Eastern GOM. Experiments on the physiologic and clinicopathologic effects of hydrocarbons have shown that major body systems of sea turtles are adversely affected by short exposure to weathered oil. Sea turtles accidentally exposed to oil or tarballs may suffer inflammatory dermatitis, ventilatory disturbance, salt gland dysfunction or failure, red blood cell disturbances, immune responses, and digestive disorders or blockages (Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Direct contact with oil may harm developing turtle embryos. Exposure to hydrocarbons may be fatal, particularly to juvenile and hatchling sea turtles.

Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus, and to even seal the mouth (Witham, 1978; Overton et al., 1983; Van Vleet and Pauly, 1987; Gramentz, 1988; Lutcavage et al., 1995). Turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). Periocular tissues and other mucous membranes would presumably be most sensitive to contact with hydrocarbons. Skin damage in turtles is in marked contrast to that observed in dolphins, where all structural and biochemical changes in the epidermis were minor and reversible. Changes in the skin are consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Turtles surfacing in an oil spill will inhale oil vapors. Any interference with operation of the lungs would probably reduce a sea turtle's capacity for sustained activity (aerobic scope) and its dive time, both effects decreasing the turtle's chance of survival.

Lutcavage et al. (1995) found that operation of the salt gland in sea turtles was disrupted with exposure to hydrocarbons, but the disturbance did not appear until several days after exposure. The salt glands did recover function when tested after two weeks of recovery. Prolonged interference with salt gland functioning could have serious consequences since it would interfere with both water balance and ion regulation. Lutcavage et al. (1995) report finding oil in the feces of turtles that swallowed oil in experiments. Van Vleet and Pauly (1987) reported that oil ingested by turtles did not pass rapidly through the digestive tract but was retained within the system for a period of several days, thus increasing the likelihood that toxic components of oil could be assimilated by other internal organs and tissues of the turtle.

Significant changes in blood chemistry following contact with hydrocarbons have been reported (Lutcavage et al., 1995). Hematocrit and hemoglobin concentration decreased slightly during contact; these parameters are critical components of the blood's oxygen transport system. The most striking hematologic finding was an elevation of white blood cell count, which may indicate a "stress" reaction related to oil exposure and/or toxicity.

Eggs, hatchlings, and small juveniles are particularly vulnerable if contacted (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Female sea turtles crawling through tar to lay eggs can transfer the tar to the nest; this was noted on St. Vincent NWR in 1994 (USDOI, FWS, 1997). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Embryonic development in an egg may be altered or arrested by contact with oil (Fritts and McGehee, 1982). Fresh oil was found to be highly toxic, especially during the last quarter of the incubation period, whereas aged oil produced no detectable effects. Fritts and McGehee (1982) concluded that oil contamination of nesting beaches would have its greatest impact on nests that were already constructed; nests made on fouled beaches are less likely to be affected, if at all. However, residual oil and tarballs may be integrated into nests by nesting females. Residues may agglutinate sand grains where eggs are deposited, later impeding hatchlings from successfully evacuating nests and ultimately leading to their death. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting hydrocarbons because the currents that concentrate oil spills also form the debris mats in which young turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). This would also be true for juvenile sea turtles that are sometimes found in floating mats of sargassum. Oil slicks, slicketts, or tarballs moving through offshore waters may foul sargassum mats that hatchling and juvenile sea turtles inhabit, which would conceivably result in the loss of sea turtle habitat or the "take" of sea turtles. The result of adult sea turtles feeding selectively in surface convergence lines could be prolonged contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). High rates of oil contact in very young turtles suggest that bioaccumulation may occur over their potentially long lifespan. Exposure to hydrocarbons may begin as early as eggs are deposited in contaminated beach sand. A female coming ashore to nest might be fouled with oil or transport existing residues at the driftline to the nest. During nesting, she might push oil mixed with sand into the nest and contaminate the eggs (Chan and Liew, 1988). Assuming olfaction is critical to the process, oil fouling of a nesting area might disturb imprinting of hatchling turtles or confuse the turtles on their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985; Chan and Liew, 1988).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tarballs, and there is no firm evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986). A loggerhead turtle sighted during an aerial survey in the GOM surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of marine turtles. The effect on reproductive success could therefore be significant.

Contact with hydrocarbons may not cause direct or immediate death but cumulative sublethal effects, such as salt gland disruption or liver impairment, could impair the marine turtle's ability to function effectively in the marine environment (Vargo et al., 1986; Lutz and Lutcavage, 1989). Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995). There is evidence of bioaccumulation in sea turtles exposed for longer periods of time. After the Gulf of Iraq war, a stranded green turtle did not appear to have contacted hydrocarbons, but upon necropsy, was found to have large amounts of oil in its liver and stomach tissues (Greenpeace, 1992).

A study of turtles collected during the *Ixtoc* spill determined that the three animals found dead had oil hydrocarbons in all tissues examined and that there was selective elimination of portions of this oil, indicating that exposure to the oil was chronic. The turtles evidently did not encounter the oil shortly before death but had been exposed to it for some time (Hall et al., 1983). The low metabolic rate of turtles may cause a limited capacity to metabolize hydrocarbons. Prolonged exposure to oil may have caused the poor body condition observed in the turtles, perhaps disrupting feeding activity. In such weakened condition, the turtles may have succumbed to some toxic component in the oil or some undiscovered agent.

The primary feeding grounds for adult Kemp's ridley turtles in the northern and southern GOM are near major areas of coastal and offshore oil exploration and production (USDOC, NMFS, 1992). The nesting beach at Rancho Nuevo, Mexico, is also vulnerable and was indeed affected by the *Ixtoc* spill. The spill reached the nesting beach after the nesting season when adults had returned or were returning to their feeding grounds. It is unknown how adult turtles using the Bay of Campeche fared. It is possible that high hatchling mortality occurred that year in the oceanic waters of the Gulf as a result of the floating oil.

Spill-Response Activities

In addition to the impacts from contact with hydrocarbons, spill-response activities could adversely affect sea turtle habitat and cause displacement from suitable habitat to inadequate areas. Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings because of predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The damage assessment and restoration plan/environmental assessment for the August 1993 Tampa Bay oil spill also noted that hatchlings that were restrained during the spill response were released on beaches other than their natal beaches, thus potentially losing them from the local nesting population (FDEP et al., 1997). Additionally, turtle hatchlings and adults may become disoriented and normal behavior disrupted by human presence as well as industrial activity. Individual turtles covered with oil have been cleaned, rehabilitated, and released (e.g., FDEP et al., 1997). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). As mandated by OPA 90, seagrass beds and live-bottom communities are expected to receive individual consideration during spill cleanup. Required spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Loggerhead turtle nesting areas in the Chandeleur Islands, Cape Breton National Seashore, and central Gulf States would also be expected to receive special cleanup considerations under these regulations. Little is known about the effects of dispersants on sea turtles and, in the absence of direct testing, impacts are difficult to predict. Dispersant components absorbed through the lungs or gut may affect multiple organ systems and interfere with digestion, excretion, respiration, and/or salt-gland function. Inhalation of dispersant can interfere with function through the surfactant (detergent) effect. These impacts are similar to the empirically demonstrated effects of oil alone (Hoff and Shigenaka, 2003).

Proposed Action Analysis

Since sea turtle habitat in the Gulf includes inshore, coastal, and oceanic waters, as well as numerous beaches in the region, sea turtles could be impacted by accidental spills resulting from operations associated with the proposed actions in the WPA and CPA. The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in **Chapter 4.3.1**. **Table 4-38** lists the estimates for spill magnitude and abundance for Gulf coastal waters as a result of a proposed action, and **Table 4-35** gives similar data for Federal OCS waters. However, estimates of where these accidents occur relative to water depth are not presented. Qualitative inspection of spill data indicates that the following will likely be in each planning area: many, frequent, small spills; few, infrequent, moderate-sized spills; and a single, unlikely, large spill. Such spills are attributed to a proposed action. The assessment of spill frequency (i.e., frequent, infrequent, unlikely) is based relative to the 40-year life span of a proposed action.

Oil spills introduced specifically into coastal waters (as opposed to spills immigrating to coastal waters from offshore) as a result of a proposed action are assumed to encroach upon adjacent coastal lands. **Table 4-38** shows the estimated oil that would be introduced into coastal waters as a result of a proposed action.

The OSRA modeling results indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters stands a 10-16 percent probability of impacting Texas State waters, based on a proposed action for the WPA (**Figure 4-13**). Should a large oil spill occur as a result of a proposed action in the CPA, Texas State offshore waters run a 2-3 percent risk of impact (**Figure 4-13**). State offshore waters of western Louisiana stand a 23-35 percent and 1-2 percent risk of impact from an OCS spill occurrence resulting from a CPA proposed action and a WPA proposed action, respectively. There is a 6-9 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River from a CPA proposed action and <0.5 percent spill risk from a WPA proposed action. The OSRA model projected a spill risk of <0.5-1 percent for coastal and offshore waters eastward of Louisiana as a result of any of proposed actions (**Figure 4-13**).

In general terms, coastal waters of the planning areas are expected to be impacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 and <1,000 bbl); and a single, large (≥1,000 bbl) spill. Pipelines pose the greatest risk of a large spill occurring in coastal waters. Matagorda County, Texas, and Plaquemines Parish, Louisiana, are the most likely landfall locations in the WPA and the CPA, respectively, where such a large spill might occur.

Because oil spills introduced specifically in coastal waters of Texas and Louisiana are assumed to impact adjacent lands, there is likelihood that spilled oil will impact sea turtle nesting beaches in these states. Nesting beaches along south Texas, such as the Padre Island National Seashore, are susceptible to such spills, thereby potentially impacting the recovery of Kemp's ridley, hawksbill, green, and loggerhead sea turtle populations in the Western Gulf. In Louisiana, loggerhead nesting beaches on the Chandeleur

Islands are vulnerable to an oil spill originating in adjacent waters; however, the hurricane damage suffered by these islands in the last few years has likely rendered them unsuitable for nesting beaches.

Depending on the timing of the spill's occurrence in coastal waters, its impact and resulting cleanup may interrupt sea turtle migration, feeding, mating, and/ or nesting activity for extended periods (days, weeks, months). Spills originating in or migrating through coastal waters of Texas or Louisiana may impact any of the five sea turtle species inhabiting the Gulf. Kemp's ridley is the most endangered sea turtle species and is strongly associated with coastal waters of Texas and Louisiana. Also, green, hawksbill, loggerhead, and leatherback sea turtles use coastal waters of the Western Gulf. Aside from the acute effects noted if sea turtles encounter an oil slick, the displacement of sea turtles to less suitable habitats from habitual feeding areas impacted by oil spills may increase vulnerability to predators, disease, or anthropogenic mortality. A high incidence of juvenile sea turtle foraging occurs along certain coastal regions of the Gulf Coast. Prime examples of known foraging areas for juvenile sea turtles in the Gulf are the Texas Laguna Madre, extending from the Texas-Mexico border to Mansfield Pass, Texas, for green turtles; and Sea Rim State Park, Texas, to Mermentau Pass, Louisiana, for Kemp's ridleys (Renaud, 2001). The interruption of mating and nesting activities for extended periods may influence the recovery of sea turtle populations. For example, a large oil spill could inhibit the mating or nesting activity of the Kemp's ridley sea turtle at Texas beaches by limiting the number of eggs being fertilized or the number of nests being constructed for one or more years.

Estimates from spill data show that Federal offshore waters will be subjected to many frequent small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 and <1,000 bbl); and/or rare large spills (**Table 4-35**) as a result of the proposed actions. Spill estimates for the WPA indicate 57-99 bbl of oil will be introduced in offshore waters from small spills (≤1 bbl). An additional 371-1,245 bbl of oil will be spilled in quantities of a >1 to <1,000 bbl spill event. A single, large spill (≥1,000 bbl) is estimated to introduce approximately 4,600 bbl of oil. A single, but unlikely, spill may occur that introduces as much as 15,000 bbl of oil. The total volume of oil spilled in Federal offshore waters as a result of the proposed actions in the WPA is estimated at 371-20,845 bbl of oil spread over the 40-year life span of the proposed actions.

Oil-spill data derived from historical trends estimate that a total volume of 5,666-26,575 bbl of oil will be introduced into Federal offshore waters over 40 years as a result of the proposed lease sales in the CPA. Small spills (≤1 bbl) are projected to introduce 182-304 bbl of oil. Moderate-sized spills (>1 and <1,000 bbl), though occurring less frequently than smaller spills, will introduce an estimated 884-2,071 bbl of oil. One or two large spills (≥1,000 bbl) are assumed to introduce approximately 4,600-9,200 bbl of oil as a result of proposed actions in the CPA. In the rare event that a spill exceeding 10,000 bbl should occur, it is estimated that approximately 15,000 bbl of oil will be spilled.

All neonate sea turtles undertake a passive voyage via oceanic waters following nest evacuation. Depending on the species and population, their voyage in oceanic waters may last 10 or more years. Beaches of the Caribbean Sea and GOM are used as nesting habitat, and hatchlings evacuating these nesting beaches emigrate to oceanic waters seaward of their nesting sites. Surface drifter card data (Lugo-Fernandez et al., 2001) indicate that circulation patterns in the Caribbean Sea and southern GOM may transport neonate and young juvenile sea turtles from these areas to oceanic waters off the coasts of Texas and Louisiana. Moreover, these journeys begin as pulsed events, with many hatchlings emerging and emigrating offshore at the same times. Oceanic OCS waters of the GOM are also inhabited by subadult and adult leatherback and loggerhead sea turtles; however, adults of any endemic sea turtle species may be found offshore. Consequently, intermediate to large spills occurring in these waters may impact multiple turtles, particularly neonate or young juvenile sea turtles associating with oceanic fronts or refuging in sargassum mats where oil slicks, decomposing residues, and tarballs are likely to accumulate. Large spills, particularly those flowing fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased risk of impacting sea turtles inhabiting these waters. It is noteworthy that such an event may impact entire cohorts originating from nesting beaches in the Caribbean or southern Gulf, as well as those originating from Texas and Louisiana nesting beaches.

There is an extremely small probability that a single sea turtle will encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over 40 years increases the likelihood that an animal will encounter a single slick during the lifetime of an animal; many sea turtle species are long-lived and may traverse throughout waters of the northern Gulf.

The web of reasoning is incomplete without considering the abundance (stock or population) of each species inhabiting the Gulf. The likelihood that members of a sea turtle population (e.g., Kemp's ridley) may encounter an oil slick resulting from a single spill during a 40-year period is greater than that of a single individual encountering a slick during its lifetime. It is impossible to estimate precisely what sea turtle species, populations, or individuals will be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to estimating when and where oil spills will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with the proposed actions and the distribution of sea turtles in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that the WPA and CPA proposed actions may introduce 11,167-31,777 bbl of oil into Gulf offshore and coastal environments over 40 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers. **Chapter 4.3.1.6.4** details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), sea turtles of any life history stage may be exposed via the waters that they drink and swim, as well as via the prey they consume. For example, tarballs may be consumed by sea turtles and by other marine organisms, and eventually bioaccumulate within sea turtles. Although sea turtles may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a sea turtle is exposed to oil resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of the proposed actions during their lifetimes.

In general, on a yearly basis, about 1 percent of strandings identified by the U.S. Sea Turtle Stranding Network are associated with oil (e.g., Teas and Martinez, 1992). Turtles do not always avoid contact with oil (e.g., Lohoefener et al., 1989). Contact with petroleum and consumption of oil and oil-contaminated prey may seriously impact turtles; there is direct evidence that turtles have been seriously harmed by petroleum spills. Oil spills and residues have the potential to cause chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on turtles.

Due to spill response and cleanup efforts, much of an oil spill may be recovered before it reaches the coast. However, cleanup efforts in offshore waters may result in additional harm or mortality of sea turtles, particularly to neonates and juveniles. Oil spills and spill-response activities at nesting beaches, such as beach sand removal and compaction, can negatively affect sea turtles. Although spill-response activities such as vehicular and vessel traffic during nesting season are assumed to affect sea turtle habitats, further harm may be limited because of efforts designed to prevent spilled oil from contacting these areas. Increased human presence could influence turtle behavior and/or distribution, thereby stressing animals and making them more vulnerable to predators, the toxicological effects of oil, or other anthropogenic sources of mortality.

In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. Fortunately, improvements in technology and equipment have greatly decreased the occurrence of blowouts.

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to sea turtles occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to sea turtles. Sea turtle hatchling exposure to, fouling by, or consumption of tarballs persisting in the sea following the dispersal of an oil slick by would likely be fatal.

4.4.7. Impacts on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Direct contact with spilled oil can cause skin and eye irritation and subsequent infection for endangered beach mice. The fur will be matted and lose its insulation against heat and cold. Sweat glands, ear tissues, and throat tissues may be irritated or infected. Disruption of sight and hearing increases vulnerability to predators. Other direct toxic effects may include asphyxiation from inhalation of fumes, oil ingestion, and food contamination. Indirect impacts from oil spills would include reduction of food supply, destruction of habitat, and fouling of nests. Recovery of habitat from hurricanes involves a vital link between mouse food supply (involving seeds of dune-stabilizing vegetation) and habitat. The link is not unique to the beach mouse (it may occur in many habitats) and may be lost after an oil spill, and loss may result in extinction of the beach mouse after later serious storms or hurricanes or further beachfront development disrupt habitat. Impacts can also occur from spill-response activities. Vehicular traffic and other activities associated with oil-spill cleanup can degrade preferred habitat and cause displacement of mice from these areas.

The ranges of the four endangered subspecies of beach mice are shown in **Figure 4-21**. For a WPA proposed action or a CPA proposed action, the probabilities were low (<0.5%) that one or more offshore spills ≥1,000 bbl would occur and contact the shoreline inhabited by the Alabama, Choctawhatchee, St. Andrews, and Perdido Key beach mice during the life of a proposed action (2007-2046).

There is no definitive information on the persistence of oil, in the event that a spill were to contact beach mouse habitat. In Prince William Sound, Alaska, after the *Exxon Valdez* spill in 1989, buried oil has been measured in the intertidal zone of beaches, but no effort has been made to search for residual buried oil above high tide. Similarly, NRC (2003) makes no mention of studies of oil left above high tide after a spill. Regardless of the potential for persistence of oil in beach mouse habitat, a slick cannot wash over the fore dunes unless carried by a heavy storm swell. Oiling of beach mice could result in extinction if it happens on a large scale (over the entire range of one of the subspecies), but this is very unlikely, given the chance of impact to the habitat is less than 0.5 percent.

Summary and Conclusion

Given the low probability of a major (≥1,000 bbl) spill occurring, direct impacts of oil spills on beach mice from a proposed action are highly unlikely. Oil-spill response and clean-up activities could have significant impact to the beach mice and their habitat if not properly regulated.

4.4.8. Impacts on Coastal and Marine Birds

Oil Spills

Oil spills pose the greatest potential impact to coastal and marine birds. Pneumonia is not uncommon in oiled birds and can occur when birds, attempting to clean their feathers through preening, inhale droplets of oil. Exposure to oil can cause severe and fatal kidney damage (reviewed by Frink, 1994). Ingestion of oils might reduce the function of the immune system and, thus, reduce resistance to infectious diseases (Leighton, 1990). Ingested oil may cause toxic destruction of red blood cells and varying degrees of anemia (Leighton, 1990). Stress and shock enhance the effects of exposure and poisoning. The pathological conditions noted in autopsies may be directly caused by petroleum hydrocarbons or may be a final effect in a chain of events with oil as the initial cause and generalized stress as an intermediate cause (Clark, 1984). Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration.

If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills resulting from accidents in navigation waterways can contact and affect many of the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Some deaths from these groups are to be expected. Raptors, such as the bald eagle and peregrine falcon, feed upon weakened or dead birds (and fish, in the case of the eagle) and as a result may become physically oiled or affected by the ingestion of the oiled prey. Pelicans are active swimmers and plunge dive for prey. They are therefore susceptible to both physical oiling and secondary effects via ingestion of oiled prey (i.e., fish).

Plovers congregate and feed along tidally exposed banks and shorelines, following the tide out and foraging at the water's edge. They have short stout bills and chase mobile prey rather than probing into the sediment with long slender bills like many birds of the sandpiper family. Plovers can physically oil themselves while foraging on oiled shores or secondarily contaminate themselves through ingestion of oiled intertidal sediments and prey. Oil will reach the intertidal beach feeding areas before it will contact nests on the fore dunes. The least tern captures fish by means of shallow splash diving and surface dipping techniques. Some physical oiling could occur during these dives, as well as secondary toxic effects through the uptake of prey. It is possible that some death of endangered/threatened (as well as nonendangered and nonthreatened) species could occur, especially if spills occur during winter months when raptors and plovers are most common along the coastal Gulf or if spills contact preferred or critical habitat. Recruitment through successful reproduction is expected to take several years, depending upon the species and existing conditions.

Direct oiling of wading birds, including some long-legged shorebirds, is usually minor because they will only be contaminated by a slick on the sea surface, which may contact the birds' legs, necks, bills, and heads, but little else, when they are feeding through the slick. Many of these birds are merely stained as a result of their foraging behaviors (Vermeer and Vermeer, 1975). Redwing blackbirds depend on stiff cattails to support their nests, so injury to such plants could result in reproductive failure. Birds can ingest oil when feeding on contaminated food items or drinking contaminated water. Oil contamination will affect prey upon which birds depend. Prey populations after the *Arthur Kill* spill (January 1990, south coast of New York) had not returned to normal a year after the spill.

Geese and herbivorous ducks feed at a lower trophic level than the other species of waterbirds and may not suffer damaging effects when oil is biomagnified, or at least not to the same degree (Maccarone and Brzorad, 1994). They still may encounter lower food availability, owing to the localized destruction of aquatic vegetation. Birds, such as ibises, that sift through mud and other sediments for small invertebrates may be exposed to high toxin levels in the invertebrates (Maccarone and Brzorad, 1994). Chapman (1981) noted that oil on the beach from the 1979 *Ixtoc* spill caused habitat shifts by the birds. Many birds had to feed in less productive feeding habitats. Similar observations were made for wading birds after the *Arthur Kill* spill (Maccarone and Brzorad, 1995). Composition of prey populations changed after the spill.

Lush vegetation helps to conceal sparsely placed nests and their contents from potential predators. Shoreline vegetation may die after prolonged exposure to water contaminated with oil. With destruction of vegetation, aerial predators may have easier access to eggs and chicks (Maccarone and Brzorad, 1994). Many species have inherently low reproductive potential, slowing recovery from impacts.

A population that endures oil-spill impacts may have the disadvantage of a long-flying distance to habitat of neighboring colonies. Otherwise, neighboring colonies' habitat could provide refuge for a bird population fleeing impacts and be a source of recruitment to a population recovering from impacts (Cairns and Elliot, 1987; Trivelpiece et al., 1986; Samuels and Ladino, 1983/1984). In that case, population recovery following destruction of a local breeding colony or a large group of wintering migrants would likely occur within 1-2 yearly breeding cycles. For many coastal and marine species, spills may delay the maturation and reproduction process in juveniles, and this could cause a decrease in reproductive success for at least one season (Butler et al., 1988). Disruption of pair bonds and altered cycles of reproductive hormones might also affect reproductive success for one breeding season (Leighton, 1990).

Oil-Spill Response and Cleanup Activities

Oil-spill cleanup methods often require heavy trafficking of beaches and wetland areas, application of oil dispersants and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other technological creations, will also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat like that of oil to successful reproduction in birds (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone would; however, successful dispersal of a spill will generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in size of an established breeding population may also be a result of disturbance in the form of personnel for shoreline cleanup, monitoring efforts, or the intensified research activity after oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, are also not effective (Clark, 1984).

Summary and Conclusion

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigated waterways can contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

4.4.9. Impacts on Endangered and Threatened Fish

4.4.9.1. Gulf Sturgeon

Gulf sturgeon critical habitat in the Gulf extends from Lake Borgne in Louisiana to the Suwannee Sound in Florida (**Chapter 3.2.7.1**). Although this is not the full range of occurrence of Gulf sturgeon, these areas constitute the most crucial habitat for the conservation of the Gulf sturgeon. The potential for impact to critical habitat or Gulf sturgeon by spilled oil is one of the greatest concerns for this resource. Oil spills are the OCS-related factor most likely to impact the Gulf sturgeon.

Oil can affect Gulf sturgeon by direct ingestion or ingestion of oiled prey or by the absorption of dissolved petroleum products through the gills. Upon any exposure to spilled oil, liver enzymes of adult fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon could result in mortality or sublethal physiological impacts including irritation of gill epithelium and disturbance of liver function. Behavior studies of other fish species suggest that adult sturgeon are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982).

Fish eggs and larvae, with their limited physiology and mobility, are killed when contacted by oil (Longwell, 1977).

Gulf sturgeon generally spend at least six months of the year in riverine and estuarine habitats inland from coastal waters and beaches. Spawning takes place when eggs are deposited in inland waters, and young Gulf sturgeon are believed to remain upstream for perhaps their first two years. The probability of spilled oil encroachment into an inland waterway is less than for the adjoining coastal area, and diminishes even further as one moves upstream. Spilled oil is very unlikely to impact adult and juvenile Gulf sturgeon and eggs when they are in the inland, riverine portion of their life cycle.

Because of the floating nature of oil and the small tidal range in the coastal Gulf, oil spills alone would typically have very little impact on benthic feeders such as the Gulf sturgeon. Unusually low tidal events, increased wave energy, or the use of oil dispersants increases the risk of impact with bottom-feeding and/or bottom-dwelling fauna. For this reason, dispersants are not expected to be used with coastal spills. Dispersants would likely be used for offshore spills and are expected to disperse about 65 percent of the volume of a spill (**Chapter 4.3.5**). Winds and currents will also diminish the volume of a slick. For the Louisiana waters and beaches with a higher probability of oil-spill occurrence than the surrounding areas, the Mississippi River outflow would also serve to help break up a slick that might otherwise contact the area. Spreading of the slick would reduce the oil concentrations that might impact the coastal Gulf sturgeon critical habitat.

Proposed Action Analysis

Figure 4-19 shows the area analyzed for oil spills. The critical habitat is encompassed in this slightly larger area of Gulf sturgeon occurrence. The probability of an offshore oil spill ≥1,000 bbl occurring and contacting the area of known Gulf sturgeon locations is given as 6-9 percent for a CPA proposed action. The probability for a WPA proposed action is listed as very negligible, less than 0.5 percent, as the critical habitat and sturgeon occurrence are east of the Mississippi River. The probability of an oil spill occurring and contacting eastern Louisiana offshore waters is 6-9 percent for a CPA proposed action, but in Mississippi offshore waters this probability to 1 percent for a CPA proposed action. As shown on **Figure 4-15**, probabilities further decrease eastward. The risk of exposure of Gulf sturgeon to such a spill would be dependent on the species abundance and density, as well as the size and persistence of the slick.

In total, about 400-21,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 800-1,500 spill events as a result of a proposed action in the WPA, and about 5,500-26,500 bbl of oil are estimated to be spilled in the offshore waters from the estimated 2,700-4,500 spills as a result of a proposed action in the CPA. Most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from 1-2 spill incidents in the ≥1,000 bbl size group and one spill in the ≥10,000 bbl size group.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and a few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

The coastal waters inhabited by Gulf sturgeon and comprising the critical habitat are not expected to be at risk from coastal spills resulting from a proposed action. Considering the projected use of shore bases in support of activities resulting from a proposed action (**Chapter 4.1.2.1.1**), very few of the estimated 46-102 coastal spills resulting from a proposed action in the CPA are likely to occur east of the Mississippi River. No coastal spills are projected to occur in Mississippi, Alabama, or Florida coastal waters as a result of a proposed action in the CPA.

Several factors influence the probability of spilled oil contact with Gulf sturgeon or their critical habitat:

- The anadromous migrations and the spawning and lengthy habitations of inshore, riverine areas greatly diminishes the probability of spilled oil contact with Gulf sturgeon.

- The floating nature of oil and the lack of large tidal ranges, as well as the influence of the Mississippi River outflow to help disperse slicks, diminishes the probability of significant impact of spilled oil on Gulf sturgeon or critical habitat.
- The very low probability of a large offshore oil spill contacting Gulf sturgeon critical habitat in all but the very westernmost area diminishes potential impact to Gulf sturgeon or alteration of critical habitat.
- The extremely low probability of a coastal spill impacting east of the Mississippi River, and thus the designated critical habitat, diminishes the probability of oil impacts to critical habitat.

Summary and Conclusion

The Gulf sturgeon could be impacted by oil spills resulting from a proposed action. Contact with spilled oil could have detrimental physiological effects. However, several factors influence the probability of spilled oil contact with Gulf sturgeon or their critical habitat. The likelihood of spill occurrence and subsequent contact with, or impact to, Gulf sturgeon and/or designated critical habitat is extremely low.

4.4.10. Impacts on Fish Resources, Essential Fish Habitat, and Commercial Fishing

Accidental events that could impact fish resources, EFH, and commercial fisheries include blowouts and oil or chemical spills (including bulk drilling muds). Due to the close association between discussions and proposed action analyses, the previously separate treatment of commercial fisheries has been combined in this single section. Impacts from other than accidental sources are discussed in **Chapters 4.2.1.1.8 and 4.2.2.1.10** for fish resources and EFH and in **Chapters 4.2.1.1.9 and 4.2.2.1.11** for commercial fishing.

Blowouts

Subsurface blowouts have the potential to adversely affect fish resources and commercial fishing. A blowout at the seafloor could create a crater, and resuspend and disperse large quantities of bottom sediments within a 300-m radius from the blowout site, potentially affecting a limited number of fish in the immediate area. A blowout event, though highly unlikely, could cause damage to the nearby bottom and render the affected area closed to bottom commercial fisheries, such as bottom longlining for tilefish or grouper, for some period of time. The majority of mobile deep-sea benthic or near-bottom fish taxa would be expected to leave (and not reenter) the area of a blowout before being impacted by the localized area of resuspended sediments.

Resuspended sediments may clog gill epithelia of finfish with resultant smothering. Settlement of resuspended sediments may directly smother deep-water invertebrates. However, coarse sediment should be redeposited within several hundred meters of a blowout site. Finer sediments can be more widely dispersed and redeposited over a period of hours to days within a few thousand meters (yards) depending on the particle size. Oil loss from a blowout is rare. Less than 10 percent of blowouts in recent history have resulted in spilled oil. Gas blowouts are less of an environmental risk, resulting in resuspended sediments and increased levels of natural gas for a few days very near the source of the blowout. Loss of gas-well control does not release liquid hydrocarbons into the water. Natural gas consists mainly of methane, which rapidly dissolves in the water column or disperses upward into the air (Van Buuren, 1984).

Spills

The risk of oil spills from a proposed action is discussed in detail in **Chapter 4.2.1.1.4**, Risk Characterization for Proposed Action Spills; their characteristics, sizes, frequency, and fate are summarized in this chapter. Spills that may occur as a result of a proposed action have the potential to affect fish resources, EFH, and commercial fishing in the GOM. The toxicity of an oil spill depends on the concentration of the hydrocarbon components exposed to the organisms (in this case fish and shellfish) and the variation of the sensitivity of the species considered. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question. In this case, hydrocarbons are the primary pollutants of concern. The effects on and the extent of damage to fisheries resources and GOM commercial fisheries from a petroleum spill are restricted by time and location. The impacts discussed in this EIS can be estimated from examinations of large accidental spills from the last 20 years such as the *North Cape* (Rhode Island, 1996), Breton Point (*Vessel World Prodigy*, Rhode Island, 1989), *Sea Empress* (United Kingdom, 1996), and *Exxon Valdez* (Alaska, 1989) (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). A more recent spill event, the breakup and sinking of the tanker *Prestige*, occurred off the coast of Spain in November 2002 (Martinez-Gomez et al., 2006; Serrano et al., 2006). The amount of oil spilled by each event and its estimated impact to fishing practices, fish resources, and fisheries economics can be used as a guideline to estimate the impacts on fisheries.

The direct effects of spilled petroleum on fish occur through the ingestion of hydrocarbons or contaminated prey, through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles, and through the death of eggs and decreased survival of larvae (NRC, 1985 and 2002). Upon exposure to spilled petroleum, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Payne et al. (1988) looked at the effects of hydrocarbon contamination in sediments and found small increases in mixed-function oxygenase (MFO) liver enzymes at exposure levels as low as 1.0 mg/kg. The liver is the primary site of MFO activity in fish, and the liver, gut, and gall bladder are primary sites of PAH concentration, metabolism, and excretion. Humans do not normally consume these organs (Brooks 2004). Ordinary environmental stresses may increase the sensitivity of fish to petroleum toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985).

When contacted by spilled hydrocarbon, floating eggs and larvae, with their limited mobility and physiology, and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977). Large numbers of fish eggs and larvae have been killed by oil spills. Sublethal effects on larvae, including genotoxic damage have been documented from sites oiled from the *Exxon Valdez* (DeMarty et al., 1997). Hose and Brown (1998) also detected genetic damage in Pacific herring from sites within the oil trajectory of the *Exxon Valdez* spill two months after the spill with decreasing rates of genotoxicity for two additional months after the spill. No genotoxicity was detectable from sampling conducted two years following the spill. Mortality rates for pink salmon embryos were found to be significantly higher than controls at exposure levels of 1 ppb total PAH concentration (Heintz et al., 1999).

Fish over-produce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. Even a heavy death toll of eggs and larvae from an oil spill may have no detectable effect on the adult populations exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of fish eggs and larvae of pilchard and pollack, respectively, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991).

Impacts of oil spills on adult fish have generally been thought to be minimal. The NOAA Office of Response and Restoration Internet website states, “Most often, fish either are unaffected by oil, or are affected only briefly” (USDOC, NOAA, 2006). Adult fish are likely to actively avoid a spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982; Maki et al., 1995). Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (Lancaster et al., 1998; Squire, 1992). Fish swim away from spilled oil, and this behavior explains why there has never been a commercially important fish-kill on record following an oil spill. Modeling of impacts for the *North Cape* spill is an exception (French, 1998). The impact modeling for this heating oil spill off Rhode Island in 1996 included theoretical mortalities of adult fish, but the model does not consider any avoidance of the spill area and mortality *estimates* were based on normal populations found in the area from previous trawling databases. The *North Cape* spill was also unusual due to conditions that caused heavy entrainment of pollutants from large-wave turbulence, and hydrocarbons were retained in shallow water for many days due to tidal currents. Some recent work has demonstrated avoidance of extremely small concentrations of hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7 µg/l by a species of minnow. There would be exceptions for some species such as salmon with strong behavior drives for reproductive or other movement patterns (Birtwell and McAllister, 2002)

Another well-recognized exception for potential harm is shoreline stranding of large amounts of oil, but even here it has to be realized that, under most circumstances, effects would be localized, impacting stationary or relatively immobile species and not fish. The only substantial adult fish-kill on record following an oil spill was on the French coast when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck. In addition, some concerns about the impact of spilled oil on the breeding cycle of commercial fishery resources have proved to be unfounded (Baker et al., 1991). Some recent work has reported potential sublethal impacts including the expression of subclinical viral infection correlated to experimental exposure of adult Pacific herring exposed to weathered crude oil (Carls et al., 1998). Birtwell and McAllister (2002) reviewed the impacts of an oil well blowout off British Columbia in 1985 and concluded that serious impacts on fish eggs, larvae, juveniles, and maturing fish are possible. They also stated that spills are not improbable and that concentrations of spilled oil can be high enough to contaminate large numbers of some fish species, such as young salmon, causing major losses; although no evidence was presented that such mortality did occur as a result of the blowout described.

Spills that contact coastal bays, estuaries, and waters of the OCS when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. For eggs and larvae contacted by a spill, the effect is expected to be lethal. A spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs. Migratory species, such as mackerel, cobia, and crevalle, could be impacted if a spill contacts nearshore open waters. The nearshore fishery was closed for approximately nine weeks in the case of the *North Cape* spill where dispersal of spilled oil away from shallow water was very slow. Chronic petroleum contamination in an inshore area would affect all life stages of a localized population of a sessile fishery resource such as oysters. Nonmotile shellfish (e.g., oysters) would not be able to avoid a spill but could shut down filtering for some period of time, depending on the water temperature and other environmental conditions.

For OCS-related spills to have an effect on an offshore commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be abnormally concentrated in the immediate spill area (Pearson et al., 1995). Hydrocarbon components also would have to be present in toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). Some reports indicate the impact of exposure of fish fry is limited. Birtwell et al. (1999) reported that exposure of populations of pink salmon fry to the aromatic hydrocarbon, water-soluble fraction of crude oil for 10 days and released to the Pacific Ocean did not result in a detectable effect on their survivability to maturity. Rice et al. (2001) reported a number of the conflicting conclusions between studies performed under the Natural Resource Damage Assessment (NRDA) organization and other studies funded through other scientists by Exxon. One major difference between studies was that NRDA studies found increased pink salmon mortality was thought to be because of *Exxon Valdez* oil up to 4 years after the spill. Other studies funded by Exxon found no evidence of increased embryo mortality. Rice et al. (2001) also indicated that different experimental designs were likely responsible, with little possibility of reconciling the two. NRC (2002) also indicated the supposed damage to pink salmon as a result of the *Exxon Valdez* oil spill has been controversial. Rice et al. (2001) did include summary statements including: both NRDA and Exxon-funded research concluded that long-term damage in the pink salmon population as a whole was not evident and that the population collapse of 1992 and 1993 was unlikely because of oil toxicity.

Pearson et al. (1999) analyzed hypotheses of why the Pacific herring fisheries in Prince William Sound collapsed in 1993 and 1994, three years after the *Exxon Valdez* oil spill. A number of factors analyzed indicated that the 1989 oil spill did not contribute to the 1993 decline, including the record high levels of harvests of Prince William Sound herring in the years immediately following the oil spill, the lack of change from the expected age-class distribution, and the low level of oil exposure documented for the herring in 1989. More recently, Peterson et al. (2003) reported long-term evidence of *Exxon Valdez* oil in Alaska, indicating an unexpected persistence of toxic subsurface oil and chronic exposures, even at sublethal levels, have continued to affect wildlife. They report on a number of changing paradigms in oil toxicology. One paradigm in relation to oil toxicity to fish emphasized that long-term exposure of fish embryos to weathered oil at very low levels of just parts per billion has population consequences through indirect effects on growth, deformities, and behavior with long-term consequences on mortality and reproduction. These impacts were especially relevant in the Alaska spill situation where oil in intertidal areas was sequestered in environments where degradation was suppressed by physical barriers to disturbance and oxygenation. Cold temperatures also played a major role in these environments.

Large spills in other regions demonstrate the significance of environmental conditions on the long-term impacts of spilled oil. In contrast to the *Exxon Valdez* spill, the impacts of the largest oil spill in history were summarized in NRC (2002); the estimated release of 17 MMbbl of oil released into the Arabian Gulf during the Gulf War. The spill significantly affected shoreline habitats, and very little shoreline cleanup was attempted. Amazingly, no significant long-term impacts to subtidal habitats and communities were observed, including seagrass beds, coral patch and fringing reef, unvegetated sandy and silty substrates, and rocky outcrops (NRC, 2002, referencing Kenworthy et al., 1993, and Richmond, 1996).

Developmental abnormalities in juveniles occur naturally in wild fish populations, and the frequency of these abnormalities is increased in populations chronically exposed to petroleum. These abnormal fish do not survive long. Such delayed death is likely to have a negligible impact on commercial fisheries, as are the immediate deaths following a petroleum spill (Pearson et al., 1995).

If chemical spills occur, they would likely occur at the surface and most would rapidly dilute, affecting a small number of fish in a highly localized environment. Many of the chemical products that may be used offshore, such as methanol or hydrochloric acid, would chemically burn all exposed surfaces of fish that come in contact. The concentration of the chemical and the duration of exposure determine the extent of the chemical burn. Rapid dilution in seawater would limit the effects, and the impacts should be inconsequential. Other compounds such as zinc bromide would not readily dilute in seawater and would likely form slowly dissolving piles on the seafloor.

Some recent work has looked at the impacts of the chemical additives ethylene glycol and methanol on Florida pompano behavior and swimming speeds (Baltz and Chesney, 2005). Behavioral observations showed that 2.1 percent ethylene glycol concentration was the lowest at which individuals displayed lethargic behavior relative to controls after 24 hr. Mean swimming speeds of the pompano declined by 13.5 percent. Swimming speeds were tested using a 1.07 percent concentration of methanol resulting in a 65 percent decline in swimming performance. It was speculated that these temporary behavioral impacts could have affected an individual's ability to avoid predators and feed effectively in the wild. There were no data presented as to the volume of a spill required to produce these kinds of concentrations more than a few meters away from the location of a spill. Although storage of large volumes of these chemicals make spills a possibility, they are extremely rare. In general, although these compounds may be toxic or have behavioral impacts, mobile fishes would likely avoid them as they do oil spills. Nonmotile fish and slow-moving invertebrates could be killed. The areal extent of the impacts would be highly localized and the impacts should be inconsequential.

One remaining type of spill could result from accidental release of large volumes of drilling muds. This has occurred on occasion in deep water where drilling risers have failed and synthetic drilling fluids contained in the riser escaped to the seafloor (Boland et al., 2004). In recent instances, 600-800 bbl of synthetic drilling fluids were released. The fates and effects of such large point-source releases have not been studied to date, but a new project (Synthetic-Based Fluid Spill of Opportunity: Environmental Impact and Recovery (USDOI, MMS, 2006)) is currently funded to do just that after the next event occurs. Gallaway and Baubien (1997) did report an increased abundance of fish, 3-10 times that expected, around the Pompano platform at 565 m (1,854 ft). The increase is thought to be related to organic enrichment from synthetic drilling mud discharges that resulted in an increase in benthic animals the fish were likely feeding on.

Proposed Action Analysis

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Except for highly migratory species, new designations for EFH (**Chapter 3.2.8.2**) do not include waters from a depth of 100 fathoms to the EEZ that was previously considered EFH. The effect of accidental events from a proposed action on coastal wetlands and coastal water quality is analyzed in **Chapters 4.2.1.1.3.2 and 4.2.1.1.2.1** for the WPA, and **Chapters 4.2.2.1.3.2 and 4.2.2.1.2.1** for the entire CPA.

Loss of well control and resultant blowouts seldom occur on the Gulf OCS. The potential causes and probabilities of blowouts are discussed in **Chapter 4.3.2.** A blowout with hydrocarbon release has a low probability of occurring as a result of a proposed action. Only 1-2 blowouts are expected for the entire depth range of a proposed action area in the WPA and 2-3 in the CPA. A blowout with oil release is not expected to occur. The few blowouts that could occur in the WPA or CPA as part of a proposed action would cause limited impacts to localized areas. Given the exposure of the area to high levels of suspended sediments in the WPA and CPA, and the low probability that a large blowout would occur, blowouts are not expected to significantly affect future water quality (EFH).

Risk of Offshore Spills

The potential causes, sizes, and probabilities of petroleum spills estimated to occur during activities associated with a proposed action are discussed in **Chapter 4.3.1** and are listed in **Table 4-35** for offshore spills. Information on spill response and cleanup is contained in **Chapter 4.3.5**, Spill-Response. The most likely spill ≥1,000 bbl estimated to occur as a result of a proposed action is a pipeline break. Persistence of oil in the environment depends on a variety of factors. It is estimated that slicks from spills <1,000 bbl would persist a few minutes (<1 bbl), a few hours (<10 bbl), or a few days (10-1,000 bbl) on the open ocean. Spilled oil would rapidly spread out, evaporate, and weather, quickly becoming dispersed into the water column. Based on past OCS spill records, most spills <1,000 bbl are estimated to be diesel, which dissipates very rapidly.

The probabilities that various size offshore spills occurring over the life of a proposed action are listed in **Table 4-35**. The most likely size of offshore spill ≥1,000 bbl that is predicted to occur is 4,600 bbl. For a proposed action in the CPA, there is a 69-86 percent chance of one or more spills ≥1,000 bbl occurring. For a proposed action in the WPA, there is a 31-46 percent chance of one or more spills ≥1,000 bbl occurring. Probability of occurrence and contact with specific offshore areas are included in **Figures 4-15 and 4-16**.

The most likely source or cause of an offshore spill is also discussed in **Chapters 4.3.1.5.2 and 4.3.1.6.2.** The most frequently spilled oil has been diesel used to operate the facilities, not the crude being produced. The most likely size of spill is the smallest size group, <1 bbl. Spills that contact coastal bays and estuaries in Texas or Louisiana would have the greatest potential to affect fish resources.

The risks of an oil spill ≥1,000 bbl occurring and contacting county and parish shorelines were calculated separately for the WPA and CPA proposed actions (**Figures 4-13 and 4-14**). For the CPA proposed action, six parishes have probabilities greater than 1 percent of an oil spill occurring and contacting their shorelines within 10 days (Vermillion, 2%; Cameron, 2-3%; Terrebonne, 4-6%; Lafourche, 4-6%; Jefferson, 2-3%; and Plaquemines, 10-15%). For the WPA proposed action, no Louisiana parishes had a greater than 1 percent probability of an oil spill occurring and contacting their shorelines within 10 days. Four Texas counties have probabilities greater than 1 percent of an oil spill occurring and contacting their shorelines (Galveston, 1-2%; Brazoria, 1-2%; Matagorda, 3-5%; and Calhoun, 1-2%).

The risks of offshore spills ≥1,000 bbl occurring, and contacting specific sensitive biological features such as the Flower Garden Banks (FGB) were also calculated separately for the WPA and CPA proposed action (**Figure 4-16**). Three topographic features designated EFH Habitat Areas of Particular Concern (HAPC) will be described here (Sonnier Bank, FGB, and Stetson Bank). Other recently designated HAPC's were not analyzed, but all other features have crests deeper than 30 m (98 ft). For each proposed action, the probability of an oil spill ≥1,000 bbl occurring and passing over the Florida Middle Grounds is less than 0.5 percent. For the CPA proposed action, the probability of an oil spill ≥1,000 bbl occurring and passing over Sonnier Bank is 3-5 percent and FGB is 2-3 percent. For the WPA proposed action, the probability of an oil spill ≥1,000 bbl occurring and passing over Stetson Bank is 2-4 percent and FGB is 4-7 percent. The biological resources of other hard/live bottoms in the GOM (EFH) would remain unharmed as spilled substances could, at the most, reach the seafloor in minute concentrations considering the great distances and time required for transportation from the deepwater areas of a proposed action.

Risk from Coastal Spills

There is a small risk of spills occurring during shore-based support activities (**Chapter 4.3.1.7**). **Table 4-387** provides the number and size of spills estimated to occur as a result of proposed actions in the WPA or CPA. The great majority of these will be very small. Most of these incidents would occur at or near pipeline terminals or shore bases and are expected to affect a highly localized area with low-level impacts. As a result of spill response and cleanup efforts, most of the inland spill would be recovered and what is not recovered would affect a very small area and dissipate rapidly. A total of 15-34 coastal spills of all sizes as a result of a WPA proposed action, 46-102 coastal spills of all sizes as a result of a CPA proposed action are estimated to occur. It is also assumed that a petroleum spill would occasionally contact and affect nearshore and coastal areas of migratory GOM fisheries. These species are highly migratory and would actively avoid the spill area.

The effect of petroleum spills on fish resources as a result of a proposed action is expected to cause less than a 1 percent decrease in fish resources or standing stocks of any population.

At the expected level of impact, the resultant influence on fish populations within or in the general vicinity of the proposed lease sale area would be negligible and indistinguishable from natural population variations.

Commercial Fishing

Commercial fishermen would actively avoid the area of a blowout or spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches would prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area (Law and Hellou, 1999). This, in turn, could decrease landings and/or the value of catch for several months. However, GOM species can be found in many adjacent locations. The GOM commercial fishermen do not fish in one locale and have responded to past petroleum spills, such as that in Lake Barre in Louisiana, without discernible loss of catch or income by moving elsewhere for a few months (with the exception of the longline closure areas described in **Chapter 3.3.1**, Commercial Fishing). In the case of a blowout, it is likely that commercial fishermen would actively avoid the immediate area of an active blowout, but this restriction of pelagic fishing activity (longlining) would not represent any additional area not already restricted due to the presence of offshore structures themselves.

Summary and Conclusion

Law and Hellou (1999) make a clear summary stating, “Accidents and spillages are an inevitable consequence of the worldwide transport of crude oil and refined petroleum products by sea.” They also add that the number of major spills occurring each year has decreased since the 1970’s. Accidental events resulting from oil and gas development in a proposed action area of the GOM have the potential to cause some detrimental effects on fisheries and commercial fishing practices. A subsurface blowout would have a negligible effect on GOM fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Historically, there have been no oil spills of any size that have had a long-term impact on fishery populations. Any affected commercial fishing activity would recover within 6 months. There is no evidence at this time that commercial fisheries in the GOM have been adversely affected on a regional population level by spills or chronic contamination.

At the expected level of impact, the resultant influence on fish populations and commercial fishing activities from a proposed action would be negligible and indistinguishable from variations due to natural causes. It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

4.4.11. Impacts on Recreational Fishing

The discussion of the impacts of accidents on fish resources and commercial fishing also applies to recreational fishing (**Chapter 4.4.10**).

Oil spills and pollution events resulting from possible accidents and events associated with a WPA or CPA proposed action could have temporary and minor adverse impacts on recreational fishing. Recreational fishing boats inadvertently contacting spills or pollution caused by accidents associated with activities resulting from a proposed action could be soiled, which may require the fishermen to temporarily modify their fishing plans. Recreational fishermen can be expected to actively avoid the area of a blowout or spill.

Recreational fisheries could be affected by oil spills resulting from a WPA or CPA proposed action. Accidental oil spills can affect recreational fisheries directly by contaminating target species through ingestion of spilled oil and indirectly by degrading habitats that are critical for the survival of target species. Impacts affecting recreational species or the ability to fish for these species can have broad effects on local economies. Motels, restaurants, bait and tackle shops, charter boats, guides, and other supporting industries can experience economic losses caused by declining fishing activity. A major oil spill that degrades the aesthetic value of a particular shoreline could deter fishers from using an area even if the impact to fish stocks were negligible. Based on the number of spills estimated for the proposed actions, persistent degradation of shorelines and waters are not likely to occur.

Summary and Conclusion

The estimated number and size of potential spills associated with a proposed action's activities (**Chapter 4.3.1.2**) are unlikely to decrease recreational fishing activity but may divert the location or timing of a few planned fishing trips. Potential impacts on recreational fisheries due to accidental events as a result of a proposed action would be minor to moderate. Based on the sizes of oil spills assumed for a proposed action, only localized and short-term disruption of recreational fishing activity might result (minor impact).

4.4.12. Impacts on Recreational Resources

Oil spills can be associated with the exploration, production, or transportation phases of OCS operations. Major oil spills contacting recreational beaches can cause short-term displacement of recreational activity from the areas directly affected, including the closure of beaches for periods of 2-6 weeks or until the cleanup operations are complete. A large oil spill resulting from the proposed actions would acutely threaten recreational beaches for up to 30 days. The risk of a spill occurring and contacting recreational beaches is described under **Chapter 4.3.1.8**. Natural processes such as weathering and dispersion and human efforts to contain and remove the spill would significantly change the nature and form of the oil. Factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, cleanup methods (if any), and publicity can have a bearing on the severity of effects on a recreational beach and its use. The primary impact-producing factors associated with offshore oil and gas exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills and offshore trash, debris, and tar. All of the respondents from a total of 39 semi-structured discussions conducted from March through May 1997 for the MMS study, "Socioeconomic and Environmental Issues Analysis of Oil and Gas Activity on the Outer Continental Shelf of the Western Gulf of Mexico," recognized environmental threats posed by the nature and specific operations of the industry (Kelley, 2002). Most respondents to the study believed that a major oil spill would have devastating effects on the tourist industry. While "small" spills were deemed to occur with some frequency, it is "the big one" that people fear most. Offshore trash and tar is often noted as the second biggest threat to the conditions of the beaches in the Gulf of Mexico coastal region. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation. Soil contamination and air and water pollution created by the refining of oil and the production of petrochemical products are other areas of concern.

Figure 4-12 displays the probabilities of an oil spill of at least 1,000 bbl occurring and contacting the shoreline within 10 days. In the CPA proposed action, the probabilities are greater than 0.5 percent in the following Louisiana parishes and Texas counties: Cameron, Vermilion, Iberia, Terrebonne, Lafourche, Jefferson, St. Bernard, and Plaquemines Parishes in Louisiana and Galveston and Jefferson Counties in Texas. For the WPA proposed action, the probabilities are greater than 0.5 percent in the following Texas counties: Calhoun, Aransas, Matagorda, Brazoria, Galveston, and Jefferson. There is also a 1 percent probability for Cameron Parish in Louisiana.

Figure 4-13 displays the probabilities of oil spills of at least 1,000 bbl occurring and contacting within 10 days State offshore waters or recreational beaches as a result of a WPA or CPA proposed action. The highest probabilities of this type of oil spill are located in Louisiana offshore waters and beaches due to a CPA proposed action. Should such a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill occur, factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods would have a bearing on the severity of effects the spill would have on a recreational beach and its use. Sorenson (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded that a spill near a coastal recreational area would reduce visitation in the area by 5-15 percent over one season but would have no long-term effect on tourism.

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. An MMS-funded study investigated the abundance and sources of tarballs on the recreational beaches of the CPA (Henry et al., 1993). The study concluded that the presence of tarballs along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern.

Chapter 4.3.1.8 (Risk Analysis by Resource) summarizes MMS's information on the risk to recreational resources from oil spills and oil slicks that could occur as a result of a proposed action in the WPA or CPA. **Figure 4-15** provides the results of the analysis of the risk of a spill $\geq$1,000 bbl occurring offshore as a result of a proposed action and reaching major recreational beach areas. Large oil and petroleum product spills could occur over the next 40 years and cause temporary closure (up to 6 weeks) of park and recreation areas along the Gulf Coast and could affect tourism at the local level. The most likely source of OCS-related offshore oil spills is pipelines, which are concentrated in the Gulf. The most likely location for contact is along a stretch of coast extending from western Louisiana to eastern Texas. Spills from OCS operations or import tankers occurring in proximity to recreational beaches and coastal parks could result in shoreline oiling, leading to closure of these parks and beaches during cleanup operations which can last from 2 to 6 weeks.

Summary and Conclusion

It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short-term and localized. Should a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill result in a large volume of oil contacting a beach or a large recreational area being contacted by an oil slick, visitation to the area could be reduced by as much as 5-15 percent for as long as one season, but such an event should have no long-term effect on tourism.

Tarballs can lessen the enjoyment of the recreational beaches but should have no long-term effect on the overall use of beaches.

4.4.13. Impacts on Archaeological Resources

Spills, collisions, and blowouts are accidental events that can happen in association with oil and gas operations. If an accidental event occurs as a result of one of these events, there could be an impact to archaeological resources. Oil spills have the potential to affect both prehistoric and historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, physical impacts associated with spill cleanup operations. Impacts to prehistoric archaeological sites would be the result of hydrocarbon contamination of organic materials, which have the potential to date site occupation through radiocarbon dating techniques, as well as possible physical disturbance associated with spill cleanup operations.

4.4.13.1. Historic

The risk of contact to archaeological resources from oil spills associated with proposed action operations is described in **Chapter 4.3.1.7**. Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be a visual impact from oil contact and contamination of the site and its environment. Impacts to coastal historic sites are expected to be temporary and reversible. Should such an oil spill contact an onshore historic site, the effects would be temporary and reversible.

Oil released subsea as a result of a blowout or pipeline incident would not be expected to contact an offshore sunken historic resource such as a shipwreck.

Summary and Conclusion

Impact to a historic archaeological resource could occur as a result of an accidental spill. As indicated in **Chapter 4.3.1.8**, it is not very likely that an oil spill will occur and contact coastal historic archaeological sites from accidental events associated with a proposed action. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

4.4.13.2. Prehistoric

Prehistoric archaeological sites on barrier islands and along beaches may be damaged by oil spilled as the result of an accidental event. The risk of oil spills occurring and contacting coastal areas is described in **Chapter 4.3.1**. Direct physical contact of spilled oil with a prehistoric site could coat fragile artifacts or site features with oil. The potential for radiocarbon dating organic materials in the site also could be adversely affected. Ceramic or lithic seriation or other relative dating techniques might ameliorate this loss of information. It is also possible to decontaminate an oiled sample for radiocarbon dating. Recent investigations into archaeological damage associated with the *Exxon Valdez* oil spill in the Gulf of Alaska revealed that oil did not penetrate the subsoil or into wooden artifacts in the intertidal zone, apparently because of hydrostatic pressure (*Federal Archaeology*, 1994); however, it is not certain that this finding would hold true in the Gulf of Mexico coastal region.

Coastal prehistoric sites could experience an impact from oil-spill cleanup operations, including possible site looting from oil spill cleanup crews. Cleanup equipment could destroy fragile artifacts and disturb the provenience of artifacts and site features. Some of the coastal prehistoric sites that might be impacted by beach cleanup operations may contain unique and significant scientific information. In Louisiana, Mississippi, and Alabama, prehistoric sites occur frequently along the barrier islands and mainland coast and along the margins of bays and bayous. Paleo-Indian artifacts have been recovered from barrier islands offshore Mississippi (McGahey, personal communication, 1996). Should an oil spill contact a coastal prehistoric site, there could be a loss of significant archaeological information on the prehistory of North America and the Gulf Coast region.

Summary and Conclusion

Accidental events producing oil spills may threaten the prehistoric archaeological resources of the Gulf Coast. Impacts to prehistoric sites could occur as a result of an oil spill. Should a spill contact an archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

As indicated in **Chapter 4.3.1.8**, it is not very likely for an oil spill to occur and contact coastal and barrier island prehistoric sites as a result of a proposed action. The proposed actions are not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

4.4.14. Impacts on Human Resources and Land Use

4.4.14.1. Land Use and Coastal Infrastructure

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring clean up of any oil or chemicals spilled.

4.4.14.2. Demographics

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

4.4.14.3. Economic Factors

The resource costs of cleaning up an oil spill, either onshore or offshore, were not included in the economic analyses for a proposed action in the WPA (**Chapter 4.2.1**) and CPA (**Chapter 4.2.2**) for two reasons. First, the potential impact of oil-spill cleanup activities is a reflection of the spill's opportunity cost. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of hundreds of jobs. While such expenditures are revenues to business and employment/ revenues to individuals, the cost of responding to a spill is not a benefit to society and is a deduction from any comprehensive measure of economic output. An oil spill's opportunity cost has two generic components: cost and lost opportunity. Cost is the value of goods and services that could have been produced with the resources used to cleanup and remediate the spill if the resources had been able to be used for production or consumption. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999). The second reason for excluding the costs of cleaning up an oil-spill from the proposed action economic analyses is that the occurrence of a spill is not a certainty. Spills are unpredictable, accidental events. Even if a proposed lease sale was held, leases let, and oil and gas produced, the timing, numbers, sizes, offshore locations of occurrence, and onshore locations of contact of potential spills occurring over the life of a proposed action are all unknown variables. Additionally, the cost involved in any given cleanup effort is influenced by a variety of factors: whether or not the oil comes ashore; the type of coastal environment contacted by the spill; weather conditions at the time of the incident; the type and quantity of oil spilled; and the extent and duration of the oiling. **Chapters 4.3.1.5 and 4.3.1.6** depict the risks and number of spills estimated to occur for the proposed actions. The probabilities of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was used as an indicator of the risk of a slick from such a spill reaching sensitive coastal environments. **Figures 4-13 and 4-14** show the GOM coastal counties and parishes having a risk >0.5 percent of being contacted within 10 days by an offshore spill ≥1,000 bbl as a result of a proposed action in the WPA or CPA. Most counties and parishes have a <0.5 percent probability of a spill ≥1,000 bbl occurring and contacting (combined probability) their shorelines within 10 days; six counties in Texas and eight parishes in Louisiana have a 1-15 percent chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline within 10 days. In Louisiana, Plaquemines Parish has the greatest risk (10-15%) of a spill occurring and contacting its shoreline within 10 days as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk (3-5%) of being contacted within 10 days by a spill occurring offshore as a result of a WPA proposed action.

The immediate social and economic consequences for the region in which a spill occurs are a mix that include not only additional opportunity cost jobs and sales but also non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). **Chapter 4.3.1.8** includes additional discussions of the potential consequences of an oil spill on commercial fisheries and recreational beaches. Net employment impacts from an oil spill are not expected to exceed 1 percent of baseline employment for any EIA in any given year even if they are included with employment associated with routine oil and gas development activities associated with a WPA or CPA proposed action.

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. Findings from an MMS study investigating the abundance and sources of tarballs on the recreational beaches of the CPA concluded that the presence of tarballs along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern (Henry et al., 1993).

Summary and Conclusion

The short-term social and economic consequences for the Gulf coastal region should a spill ≥1,000 bbl occur includes opportunity cost of employment and expenditures that could have been gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill.

4.4.14.4. Environmental Justice

Oil spills that enter coastal waters can have negative economic or health impacts on the many people who use those waters for fishing, diving, boating, and swimming. The MMS estimates that coastal spills ≥1,000 bbl occurring from a proposed action have a low probability of occurrence (**Chapter 4.3.1.8 and Figures 4-14 and 4-15**).

Should an oil spill occur and contact coastal areas, any adverse effects would not be expected to disproportionately impact minority or low-income populations. The populations immediately adjacent to the coast are not physically, culturally, or economically homogenous. The homes and summer homes of the relatively affluent line much of the Gulf Coast, and this process of gentrification is ongoing. As shown by **Figures 3-21 through 3-26** and discussed in **Chapter 3.3.5.10**, coastal concentrations of minority and low-income populations are few and mostly urban. The higher probabilities of oil contacting land in Louisiana are centered on South Pass and Southwest Pass at the confluence of the deltaic plain and the GOM (**Chapter 4.3.1**). In Louisiana, Grand Isle is the only inhabited barrier island, and this community is not predominantly minority or low income. Most of the Louisiana coast, including South Pass, Southwest Pass, and the shorelines surrounding Morgan City and the lower Mississippi Delta are virtually uninhabited and uninhabitable.

The users of the coast and coastal waters are not physically, culturally, or economically homogenous. Recreational users of coastal waters tend to be relatively affluent. For example, a recent survey of recreational and party-boat fishing around offshore oil rigs found significant per capita costs (Hiett and Milon, 2002). Offshore commercial fishing involves significant capital outlays that limit participation. One MMS-funded study of the Houma in Lafourche Parish found that they focus their commercial and subsistence activities on inland and nearshore wild resources, less capital demanding pursuits (Fischer, 1970).

The direct impacts of an oil spill are unlikely to disproportionately affect minority or low-income people. Oil spills can have indirect effects, such as through serious, short-term impacts on tourism; however, these too are unlikely to disproportionately affect minority or low-income people.

Summary and Conclusion

Considering the low likelihood of an oil spill and the heterogeneous population distribution along the GOM region, accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

4.5. CUMULATIVE ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

The following cumulative analysis considers environmental and socioeconomic impacts that may result from the incremental impact of the 11 proposed lease sales when added to all past, present, and reasonably foreseeable future human activities, including non-OCS activities, as well as all OCS activities (OCS Program). Non-OCS activities include, but are not limited to, import tankering; State oil and gas activity; recreational, commercial and military vessel traffic; offshore LNG activity; recreational and commercial fishing; onshore development; and natural processes. The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the 40-year analysis period (2007-2046). This includes projected activity from lease sales that have been held, including the most recent Lease Sale 200 (August 2006), but for which exploration or development has not yet begun or is continuing. The impacts of activities associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the cumulative environmental analysis section (**Chapter 4.5**).

4.5.1. Impacts on Air Quality

The cumulative scenario for the OCS Program for 2007-2046 is shown in **Table 4-4**, which presents the numbers of exploration, delineation, and development wells; platforms installed; and service-vessel trips. The cumulative scenario estimates are based on the portion of the resources assumed to be leased, discovered, developed, and produced as a result of a proposed action, and upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. A profusion of historical databases and information derived from oil and gas exploration and development activities are available to MMS and were used extensively. The undiscovered, unleased, conventionally recoverable resource estimates for a proposed action are expressed as low to high range. The range reflects a range of projected economic valuations of the produced oil and gas.

In the cumulative analysis, the total cumulative emissions from existing sources, the proposed sales, and potential future sales are combined and the area analyzed is the entire GOM. Onshore emissions are considered in the analysis for perspective, since the combined effect of all emissions in the coastal region affects the air quality of the states bordering the Gulf.

Onshore emission sources include power generation, industrial processing, manufacturing, refineries, commercial and home heating, and motor vehicles. Nationwide, nitrogen oxide (NO_x) emissions have decreased about 12 percent in the period 1993-2002, while sulfur dioxide (SO_2) emissions have decreased about 31 percent (USEPA, 2003). Emissions of volatile organic compounds (VOC's) have decreased 25 percent in the period 1993-2002 and particulate matter (PM_{10}) emissions have decreased by 22 percent. However, the changes vary by region and in the last decade, some Gulf Coast States have observed an increase in SO_2 or NO_x emissions, while others have seen a decrease (emission tabulations by State may be found at http://www.epa.gov/air/data/geosel.html).

In the ozone (O_3) nonattainment areas, which include the Houston area in southeast Texas and the Baton Rouge area in Louisiana, emissions of NO_x and VOC are being reduced through the State Implementation Plan (SIP) process in order for those areas to achieve compliance with the national O_3 standard. Prior to the revocation of the 1-hr O_3 standard in 2004, Houston-Galveston-Brazoria and Baton Rouge were classified severe nonattainment, while the Beaumont-Port Arthur nonattainment classification was serious. While the 1-hr O_3 standard no longer applies, the same emission controls will remain in effect while the State is developing their plan to reach compliance with the new 8-hr standard. The Houston-Galveston-Brazoria area is classified moderate nonattainment for the 8-hr standard, while Beaumont-Port Arthur and Baton Rouge are marginal nonattainment. Moderate nonattainment areas are required to comply with the 8-hr standard by 2010, while marginal areas have to meet the standard by 2007.

Ozone levels in southeast Texas have been in a steady downward trend during 1995 through 2005. The maximum observed fourth highest 8-hr O_3 concentration in the Galveston-Houston area has decreased from about 0.140 ppm in 1995 to around 0.100 ppm in 2005. Yearly summaries of air pollutant values by geographic area may be obtained at http://www.epa.gov/air/data/reports.html. Ozone levels in the Baton Rouge area have remained steady over the 1995-2005 period, while the number of exceedances of the O_3 standard has been in a general downward trend. This shows that emission reduction measures have been effective in reducing O_3 levels.

The USEPA has promulgated a series of measures to reduce regional and nationwide emissions. In 1999, USEPA established emission rules for commercial marine engines. That same year emission standards were promulgated for small engines such as leaf blowers, lawn mowers, and tractors. In 2002, USEPA established regulations for large industrial engines, off-road recreational vehicles, and diesel marine engines for recreational boats. In May 2004, USEPA promulgated the Clean Air Nonroad Diesel Rule, which sets new emission limits on nonroad diesel engines. This rule will phase in standards for NO_x, PM_{10}, and SO_2. Along with this rule, USEPA issued a Notice of Intent to propose more stringent emission standards for marine vessels and locomotives.

In 2000, Phase 2 of the Acid Rain Rule (Title IV) went into effect. Under this rule, emissions of SO_2 and NO_x from power plants in the eastern half of the U.S. are projected to continue a downward trend over the next decade. In 2005, USEPA finalized the Clean Air Interstate Rule that applies to 28 states (including all of the Gulf Coast States) and the District of Columbia. This rule will place additional limitations on NO_x and SO_2 emissions from power plants. The USEPA projections indicate that by 2015 the total SO_x emissions from power plants in the five Gulf Coast States will decrease by over 40 percent compared with 2003 levels, while NO_x emissions will decrease by over 50 percent.

The effects of these various regulations and standards would tend to result in a steady, downward trend in future air emissions. This trend should be realized in spite of continued industrial and population growth. The States are required to implement SIP's to reduce emissions in the O_3 nonattainment areas. The Houston-Galveston-Brazoria area is classified moderate nonattainment for O_3 and is required to achieve the O_3 standard by June 2010. The Beaumont-Port Arthur area is classified marginal O_3 nonattainment and has to achieve the standard by June 2007. The Baton Rouge area is classified marginal nonattainment for O_3 and is required to meet the O_3 standard by June 2007.

Table 4-41 lists the yearly average emissions associated with all future OCS oil and gas activities in the GOM. The table also presents the emissions calculated from an inventory of all OCS activities collected in 2000 by Wilson et al. (2004). When we compare the future projected OCS emissions with 2000 emissions, there is a small increase in NO_x emissions, a slight decrease in SO_2 and PM_{10} emissions, and a significant increase in CO and VOC emissions. There are other emissions on the OCS that are not associated with oil/gas activities, and these include emissions from commercial marine vessels, commercial and recreational fishing, tanker lightering, military vessels, and natural sources such as oil or gas seeps. These activities are likely to increase in the future, but new USEPA emission standards for marine vessels would, to some extent, counteract the associated emissions increase.

The MMS performed a cumulative air quality modeling analysis of platform emissions in a portion of the GOM in 1992 (USDOI, MMS, 1997). The modeling incorporated a 40-percent increase in emissions above the 1992 levels to account for growth in oil and gas development. Predicted concentrations were well within the NAAQS and the PSD Class II maximum allowable increases. It is still not known whether the PSD increments have been exceeded in the Breton Class I area as one needs to consider the cumulative effect of all other emission sources in the area with respect to the baseline year. In an attempt to address this question, MMS has a modeling study underway to estimate the contribution of OCS emissions to concentrations of NO_2 and SO_2 in the Breton Class I area. This study is scheduled to be completed in 2007. In addition, MMS consults with the FWS, which is the Federal land manager of the Breton Class I area, for plans within 100 km (62 mi) of Breton that exceed a certain emission threshold.

Ozone modeling was performed using a preliminary Gulfwide emissions inventory for 2000 to examine the O_3 impacts with respect to the 8-hr O_3 standard of 80 ppb. One modeling study focused on the coastal areas of Louisiana extending eastward to Florida (Haney et al., 2004). This study showed that the impacts of OCS emissions on onshore O_3 levels were very small, with the maximum contribution at locations where the standard was exceeded by 1 ppb or less. The other modeling effort dealt with O_3 levels in southeast Texas (Yarwood et al., 2004). The results of this study indicated a maximum contribution to areas exceeding the standard by 0.2 ppb or less. The projected emissions for the cumulative case would be about the same as the emissions used in the modeling. The contributions to O_3 levels would therefore be similar. As emissions within the nonattainment areas are expected to decrease further in the future, the cumulative impacts from the OCS oil/gas program on O_3 levels would likely be reduced.

Gaseous and fine particulate matter in the atmosphere can potentially degrade atmospheric visibility. Existing visibility in the eastern U.S., including the Gulf States, is impaired because of fine particulate matter containing primarily sulfates and carbonaceous material. High humidity is an important factor in visibility impairment in the Gulf coastal areas. The absorption of water by the particulate matter makes them grow to a size that enhances their ability to scatter light and, hence, aggravate visibility reduction. The estimated natural mean visibility in the eastern U.S. is 60-80 mi (97-129 km) (Malm, 1999). On the basis of data presented by Malm (2000), the observed mean visual range is about 24-30 mi (38-48 km) in coastal Louisiana, Mississippi, and Alabama. In the Texas coastal areas, the average visibility is about 30-40 mi (48-64 km). In the Gulf Coast States, about 60-70 percent of the human-induced visibility degradation is attributed to sulfate particles, while about 20 percent of the visibility degradation is from organic or elemental carbon particles. About 8 percent of the visibility impairment is attributed to nitrate particles (Malm, 2000; USEPA, 2001c).

Visibility degradation in large urban areas, such as Houston, can be especially pronounced during air pollution episodes. In some severe cases, it may hinder navigation by boats and aircraft. Degraded visibility also adds to the perception by the observer of bad air quality even when monitors do not record unhealthful pollutant levels.

A study of visibility from platforms off Louisiana revealed that significant reductions in Louisiana coastal and offshore visibility are almost entirely due to transient occurrences of fog (Hsu and Blanchard, 2005). Episodes of haze are short-lived and affect visibility much less. Offshore haze often appears to result from plume drift generated from coastal sources. The application of visibility screening models to individual OCS facilities has shown that the emissions from a single facility are not large enough to significantly impair visibility. It is not known to what extent aggregate OCS sources contribute to visibility reductions; however, the effects from OCS sources are likely to be very minor because offshore emissions are substantially smaller than the onshore emissions.

In July 1999, USEPA published final Regional Haze Regulations to address visibility impairment in the Nation's national parks and wilderness areas (64 FR 35714). These regulations established goals for improving visibility in Class I areas through long-term strategies for reducing emissions of air pollutants that cause visibility impairment. The rule requires States to establish goals for each affected Class I area to improve visibility on the haziest days and to ensure no degradation occurs on the clearest days. Since visibility impairment involves considerable cross-boundary transport of air pollutants, States are encouraged to coordinate their efforts through regional planning organizations. Texas and Louisiana are part of the Central States Regional Air Planning Association. Mississippi, Alabama, and Florida are members of the Visibility Improvement State and Tribal Association of the Southeast. The regional planning organizations are required to submit their first implementation plan in 2008. Subsequent plans are to be submitted at 10-year intervals.

The Regional Haze Regulations, along with the rules on O_3 and acid rain, should result in a lowering of regional emissions and improvement in visibility. Projected emissions from all cumulative OCS activities are not expected to be substantially different from 2000 emissions. The contribution of OCS emissions to visibility impairment would be very minor.

Impacts from oil spills for the cumulative case would be similar to those for the proposed 2007-2012 leasing program. Since impacts from individual spills would be localized and temporary, the magnitude of impacts would be no different from those associated with the proposed action.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with the cumulative scenario are not projected to have significant effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and heights, and the resulting pollutant concentrations. Onshore impacts on air quality from emissions from cumulative OCS activities are estimated to be within Class II PSD allowable increments.

The modeling results indicate that all concentrations are below the maximum allowable PSD increments except 24-hr SO_2 and annual NO_2 for the Class I area. However, potential cumulative impacts to the Breton Wilderness Class I Area are unknown due to the baseline problem and require further study; although it should be noted that impacts from a Central proposed action are well within the PSD Class I allowable increment. The incremental contribution of the proposed actions (as analyzed in **Chapters**

4.2.1.1.1 and 4.2.2.1.1) to the cumulative impacts is not significant and is not expected to alter onshore air quality classifications.

Portions of the Gulf Coast have ozone levels that exceed the Federal air quality standard, but the cumulative contribution from the proposed actions are very small. Ozone levels are on a declining trend because of air pollution control measures that have been implemented by States. This downward trend is expected to continue as a result of local as well as nationwide air pollution control efforts.

The Gulf Coast has significant visibility impairment from anthropogenic emission sources. Area visibility is expected to improve somewhat as a result of regional and national programs to reduce emissions. The cumulative contribution to visibility impairment from the proposed actions is also expected to remain very small.

The conclusions above only consider the impact on air quality from OCS sources. If the onshore sources are considered, there may be considerable adverse effects on ozone concentration and on visibility (see also the Draft EIS on the proposed OCS Oil and Gas Leasing Program, 2007-2012; USDOI, MMS, 2006m). Thus, the OCS contribution to the air quality problem in the coastal areas is small, but total impact from onshore and offshore emissions may be significant to the ozone nonattainment areas in southeast Texas and the parishes near Baton Rouge, Louisiana.

4.5.2. Impacts to Water Quality

As discussed in **Chapters 4.2.1.1.2, 4.2.2.1.2, and 4.4.2**, impacts from the proposed actions could affect coastal, offshore, and deepwater quality. There are also a number of existing and future OCS activities that are not part of the proposed action and non-OCS activities that are ongoing or reasonably expected to take place in the Gulf in the foreseeable future that could affect water quality. Activities of the proposed action would, therefore, incrementally add to the overall cumulative impact to water quality.

Routine and ongoing OCS-related activities that can impact water quality include drilling wells, installation/removal of platforms, laying pipelines, service vessel operations, and supporting infrastructure discharges. Routine oil and gas activities potentially degrade water quality through the addition of hydrocarbons, trace metals, and suspended sediment. Accidental spills of chemicals or oil will also impair water quality temporarily. A proposed action in the WPA is projected to result in 28-41 production structures, and a proposed action in the CPA is projected to result in 28-39. A total of 2,958-3,262 structures may be added from the Gulfwide OCS Program between 2007 and 2046. At the same time, structures are being removed. An estimated 5,997-6,097 structures will be removed Gulfwide between 2007 and 2046; most removal being in water depths less than 60 m (197 ft) (i.e., on the continental shelf). At present, approximately 4,000 structures exist offshore.

Existing and future non-OCS activities occurring in the GOM that would affect water quality include the transportation of oil, gas, and commodities, and the activities of other Federal agencies, such as the DOD. Discharges from domestic and foreign commercial and military vessels would adversely affect the quality of water in the GOM.

4.5.2.1. Coastal Waters

The water quality of coastal environments will be affected by cumulative input of hydrocarbons and trace metals from activities that support oil and gas extraction. These activities include bilge water from service vessels and point and non-point source discharges from supporting infrastructure. Discharges from service vessels are regulated by USCG to minimize cumulative impacts. The USEPA regulates point-source discharges. If regulations are followed, it is not expected that additional oil and gas activities will adversely impact the overall water quality of the region.

Inflows from rivers such as the Mississippi River influence coastal water quality. When inflows transport constituents that degrade water quality, such as suspended sediments or nutrients, adverse effects can result. Such discharges impact water quality in the Gulf, and during periods of water column stratification have influenced the development of an extensive hypoxic zone. In comparison with the Mississippi and Atchafalaya Rivers' input, it is estimated that produced water contributes from 0.02 to 0.2 percent of the nitrogen to the hypoxic zone (Veil et al., 2005).

Dredging and channel erosion can add to the suspended load of local waterways. Support vessels as well as other activities such as commercial fishing and shipping use the waterways. Accurate information concerning the direct impacts from OCS activities is not available to evaluate the degradation of water quality in the waterways.

Accidental releases of oil or chemicals would degrade water quality during the spill and after until the spill is either cleaned up or natural processes disperse the spill. The effect on coastal water quality from spills estimated to occur from a proposed action (a 4,600-bbl offshore spill projected to reach coastal waters and a 3,000-bbl spill in coastal waters) are expected to be minimal relative to the cumulative effects from hydrocarbon inputs from other sources such as river outflow, industrial discharges, and bilge water releases as discussed in the National Research Council's report *Oil in the Sea* (NRC, 2003). An analysis of the source of spills identified that, for coastal spills $\geq$1,000 bbl, the source has been OCS oil 25 percent of the time. The hurricanes of 2004 and 2005 were not included in this calculation. The cumulative impacts to coastal water quality would not be changed over the long term as a result of the proposed actions.

A major hurricane can result in a greater number of coastal oil and chemical spill events with increased spill volume. As occurred in 2005, damage to infrastructure would delay response to the spills, and flooding may increase the dispersion of the spills.

Summary and Conclusion

Water quality in coastal waters will be impacted by supply vessel usage and infrastructure discharges. The incremental contribution of a proposed action to the cumulative impacts to coastal water quality is not expected to be significant as long as all regulations are followed.

4.5.2.2. Marine Waters

Water quality in marine waters will be impacted by the discharges from drilling, production, and removal activities. Sources not related to oil and gas activities that can impact marine water quality include bilge water discharges from large ships and tankers; coastal pollutants that are transported away from shore, including runoff, river input, sewerage discharges, and industrial discharges; and natural seepage of oil and trace metals.

Drilling activities add drilling mud and cuttings to the environment. From the MMS database, about 1,200 wells are spudded each year. A projected 196-288 wells will be drilled in support of a proposed action in the WPA. A projected 499-714 wells will be drilled in support of a proposed action in the CPA. The total OCS Program is projected to result in the drilling of 10,486-12,526 wells in the WPA and 28,191-32,811 wells in the CPA from 2007 to 2046. The impacts from drilling were discussed in **Chapters 4.2.1.1.2.2 and 4.2.2.1.2.2**. The impacts would be related to increased water turbidity in the vicinity of the operations and the addition of soluble contaminants to the water column. The additional impact to water quality from the proposed action would be expected to be small compared with those derived from non-OCS activities are much more extensive. Studies thus far indicate that as long as discharge regulations are followed, impacts to the marine environment from drilling activities are not significant.

Oil spills in the GOM also adversely affect water quality. Nearly 85 percent of the 29 million gallons of petroleum that enter North American ocean waters each year as a result of human activities comes from land-based runoff, polluted rivers, airplanes, and small boats and jet skis; less than 8 percent comes from tanker or pipeline spills. Oil exploration and extraction are responsible for only 3 percent of the petroleum that enters the sea. Another 1.5 MMbbl (47 million gallons) seep into the ocean naturally from the seafloor (NRC, 2003). The NRC report (2003) on oil in the sea determined that seeps are the largest source of petroleum hydrocarbons to offshore waters. Limited information is available on the levels of trace metals in Gulf of Mexico marine waters and the sources of trace-metal contamination. The USEPA (1993a and b) conducted detailed analyses of trace metal concentrations in discharges and used the data to establish criteria for the discharge of drilling wastes. Impacts from trace metal contamination are not expected to be significant.

Accidental spills of chemicals and oil are expected to impact water quality on a temporary basis and only close to the spill. Winds, waves, and currents should rapidly disperse any spill and reduce impacts.

Hurricanes may cause fuels and chemicals stored on platforms to enter the water when the structure is damaged or toppled. Structures that are blown off station may drag anchors and damage pipelines and subsea lines to release oil and chemicals. Loss of well control has not occurred as the result of hurricanes because of the built-in safety features.

Summary and Conclusion

Cumulative impacts on the water quality of the marine environment result from the addition of discharges from exploratory and production activities to a relatively pristine environment. The incremental contribution of a proposed action to the cumulative impacts to marine water quality is not expected to be significant as long as all regulations are followed.

4.5.3. Impacts on Sensitive Coastal Environments

4.5.3.1. Coastal Barrier Beaches and Associated Dunes

This cumulative analysis considers the effects of impact-producing factors related to a proposed action, prior and future OCS sales in the GOM, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes that may affect barrier beaches and dunes. Specific impact-producing factors considered in this cumulative analysis include channelization of the Mississippi River, beach protection and stabilization projects, oil spills, oil spill response and clean up activities, pipeline landfalls, navigation channels, development and urbanization, natural processes, and tourism and recreational activities.

River Channelization and Beach Protection

Erosion of barrier islands in coastal Louisiana and easternmost Texas is related to the stages of delta building and subsequent abandonment processes of the Mississippi River. The Mississippi River is the most influential direct and indirect source of sand-sized and other sediments to coastal landforms in Louisiana. Over the last 7,000 years, the Mississippi River has built six major delta lobes along the Louisiana coast (Frazier, 1967). During the active (delta-building) phase, a delta plain forms as distributaries form and branch across the prodelta platform. This delta-building process continues until the distributary course is no longer efficient and the course is changed, beginning the abandonment process. Over time, the abandoned delta complex subsides and coastal processes rework the seaward margin to form a sandy barrier shoreline backed by bays and lagoons (Kwon, 1969; Penland et al., 1981, 1988). The delta plain region of southeastern Louisiana primarily consists of deposits of abandoned and active channels and distributaries of the Mississippi River and associated backswamps, marshes, and bay deposits. After delta abandonment, the land compacts and subsides, producing a relative sea-level rise. The shoreline along the abandoned delta lobe is subject to erosion, sediment redistribution, and landward migration (transgression). Penland and Boyd (1981) describe the shoreline development of an abandoned delta in three stages. In the first stage, the once active delta is transformed into an erosional headland with flanking barrier islands. As subsidence and erosion proceed, a barrier island arc forms in the second stage (e.g., Isles Dernieres). In the third stage, the barrier islands are eroded to form an inner shelf shoal (e.g., Ship Shoal). Thus, the nature of the shoreline in the delta plain region reflects the relative age of the abandoned delta complex. Coastal barriers in this region are dynamic habitats and provide a variety of niches that support many avian, terrestrial, aquatic, and amphibian species, some of which are endangered or threatened. The coastal barrier islands of Louisiana also provide protection to the State's coastal resources from wind and wave action, saltwater intrusion, and oil spills. Furthermore, the barrier islands and fringing wetlands function as a hurricane buffer.

Since the lower Mississippi River was completely leveed and channeled by the early 1930's, the vast majority of land-building sediments have been channeled to the end of the Bird Foot Delta (EIA LA-3), from where they are largely distributed to deepwater areas of the continental slope. Levees and channelization ended the once-significant land building in Louisiana and set circumstances toward deltaic degradation and subsidence, as if the river had abandoned this area of the coast.

Within a decade after the Civil War, the State of Louisiana connected the Mississippi, Red, and Atchafalaya Rivers for navigational purposes, which began the diversion of the more sediment-laden waters of the Mississippi River to the Atchafalaya River. By 1932, the Federal Government diverted the Red River and increased Mississippi River flow to the Atchafalaya River for flood control. By 1962, the

Federal Government constructed the Old River Control Structure, which diverts approximately 30 percent of the Mississippi River flow to the Atchafalaya River. This diversion also led to the development of a new deltaic lobe in the Atchafalaya Bay (EIA LA-2).

Since the 1950's, the suspended sediment load of the Mississippi River has decreased more than 50 percent, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation measures within the drainage basin. Sediment loads in the Atchafalaya River also decreased as a result.

Reduced sediment supply to the Louisiana coast has contributed to erosional forces becoming dominant. Erosional reworking of deltaic sediments winnows away the lighter sediments and retains the heavier, sand-sized materials that build barrier beaches. Unfortunately, very little of these coarser materials are present in the deltaic deposits of these regions. Consequently, these beaches are rapidly retreating landward and will continue to do so into the foreseeable future. Generally under these circumstances, installation of facilities on these beaches or dunes or removal of large volumes of sand from this littoral system can cause strong, adverse impacts. One of the least stable beach and dune systems is at Fourchon in Lafourche Parish, where tank farms and other businesses have been forced to move inland, away from the rapidly eroding beach.

The beaches and dunes of the Chandeleur Islands to the east of the Mississippi River Delta are not dependent on a fluvial source of sand. These islands are nourished by the sandy barrier platforms beneath them (Otvos, 1980). Reduced discharges of fluvial sediment into the coastal zone will not affect these barriers. Still, their sand supplies are limited and they have not recovered rapidly after hurricanes of the last decade.

Approximately 280 km (174 mi) of the Texas coast are experiencing erosion (Wicker et. al. 1989). The weighted average erosion rate along this stretch of coast is 5.9 m/yr (19.4 ft/yr). Another 212 km (696 mi) of coast are experiencing loss at an average rate of 2.9 m/yr (9.5 ft/yr). The average change over the entire Texas coast has been erosional at a rate of 2.1 m/yr (6.9 ft/yr). During this century, the annual rate of coastal landloss in Texas has increased from 32 ac (13 ha) at the turn of the century to nearly 161 ac (65 ha) in 1980 (Morton, 1982). These trends are caused by the following circumstances:

- The Texas coast has experienced a natural decrease in sediment supply as a result of climatic changes that have occurred during the past few thousand years (Morton, 1982).
- Dam construction upstream on coastal rivers has trapped sand-sized sediments.
- Shoreline stabilization using groins and jetties has trapped sediment on the updrift sides of the structures.
- Seawall construction along eroding stretches of islands has reduced the amount of sediment introduced into the littoral system by shore erosion.
- The Texas Chenier Plain receives reworked sediments that have been discharged by the Mississippi River, which have decreased by more than 50 percent since the 1950's. Reductions in sediment supply along the Texas coast will continue to have a significant adverse impact on barrier landforms there.

Subsidence, erosion, and dredging of inland coastal areas and the concurrent expansion of tidal influences, particularly as seen in Louisiana, continually increases tidal prisms around the Gulf. These changes will cause many new natural, tidal channels to be opened, deepened and widened not only to the Gulf but also between inland waterbodies to accommodate the increasing volumes of water that are moved by tides and storms. These changes will cause adverse impacts to barrier beaches and dunes that will be incremental in nature.

Efforts to stabilize the Gulf shoreline have adversely impacted barrier landscapes in Louisiana and Texas. Large numbers and varieties of stabilization techniques, such as groins, jetties, and seawalls, as well as artificially-maintained channels and jetties, installed to stabilize navigation channels have been applied along the Gulf Coast. These efforts have contributed to coastal erosion by depriving downdrift beaches of sediments, which accelerates erosion there (Morton, 1982), and by increasing or redirecting the erosional energy of waves. Over the last 20 years, dune and beach stabilization have been better accomplished by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings.

Natural Processes

Sea-level rise and tropical and extra-tropical storms exacerbate and speed up the erosion of coastal barrier beaches along the Gulf Coast. Boyd and Penland (1988) estimated that storms raise mean water levels 1.73-2.03 m above mean sea level 10-30 times per year. Under those conditions, the barrier islands of the Mississippi River delta complex experience severe overwash of up to 100 percent of the land mass. Louisiana, in particular, is highly susceptible to hurricanes. Although Louisiana's coastal marshes and barrier islands provide a front line of defense against storm surge, 90 percent of these wetlands are at or below sea-level elevation. Furthermore, Louisiana is historically prone to major storm events. According to the LSU Hurricane Center, the central Louisiana coast has experienced landfall of more major hurricanes (Category 3 and above) than anywhere in the continental U.S. over the past century.

Hurricane Katrina in August 2005 caused severe erosion and landloss for the coastal barrier islands and beaches of the Deltaic plain. The eye of Hurricane Katrina passed directly over the 50-mi Chandeleur Island chain. Aerial surveys conducted by U.S. Geological Survey on September 1, 2005, show that these islands were heavily damaged by the storm (USDOI, GS, 2006a). Initial estimates suggest that Katrina reduced the Chandeleur Islands by one-half of their pre-storm land area. Although barrier islands and shorelines have some capacity to regenerate over time, the process is very slow and often incomplete. With each passing storm, the size and resiliency of these areas can be diminished, especially when major storms occur within a short time period. Hurricane Katrina was the fifth hurricane to impact the Chandeleur Island chain in the past 8 years. The other storms were Hurricanes Georges (1998), Lili (2002), Ivan (2004), and Dennis (2005).

Grand Isle was also heavily damaged by Katrina. Although Katrina made landfall more than 50 mi to its east, Grand Isle received extremely high winds and a 12- to 20-ft storm surge that caused tremendous structural damage to most of the island's camps, homes, and business (USDOI, GS, 2006c).

Hurricane Rita in September 2005 severely impacted the shoreface and beach communities of Cameron Parish in southwest Louisiana and the southeast Texas coast. Some small towns in this area have no standing structures remaining. A storm surge approaching 6 m (20 ft) caused beach erosion and overwash, which flattened coastal dunes depositing sand and debris well into the backing marshes.

Winter storms driven by masses of cold Arctic air are responsible for significant landlosses in the Gulf Coast region (Roberts et al., 1987; Pilkey et al., 1989). In the Gulf Coast region, frontal-related storms occur about every 7-10 days from November to April. These storms act like pumps that cause rapid changes in water levels and associated wave erosion. Preceding the passage of a cold front, low barometric pressure generates strong onshore winds that set water up along the coast, flooding open ocean and mainland beaches and exposing the shores to strong wave attack. As the front passes the coast, strong winds are directed offshore driving water onto the backbarrier flats and away from the ocean beaches. The frequent oscillation in water levels and waves erodes both sides of barrier islands as well as mainland and bay shores (Morton, 2003).

A variety of beach and barrier island restorative measures have been brought about as the population has become more aware of barrier island and beach problems. During the mid-1980's, the COE contracted with the State of Louisiana and the Jefferson Parish governments to replenish beach sand on Grand Isle, Louisiana. During the 1990's, the State of Louisiana and Federal Government joined in a partnership through the Coastal Wetlands Protection, Planning and Restoration Act (CWPPRA) to address and, where possible, correct the deterioration of wetlands and barrier islands along Louisiana's Gulf Coast and elsewhere.

Oil Spills

Sources and probabilities of oil entering waters of the Gulf and surrounding coastal regions are discussed in **Chapter 4.1.3.4**. Inland spills that do not occur in the vicinities of barrier tidal passes are more likely to contact the landward rather than the ocean side of a barrier island. Hence, no inland spills are expected to significantly contact barrier beaches (**Chapters 4.2.1.1.3.1 and 4.2.2.1.3.1**).

Most spills occurring in offshore coastal waters are assumed to proportionally weather and dissipate similar to the weathering described in **Tables 4-36 and 4-37**. Dispersants are not expected to be used in coastal waters. The weathering model described in **Chapter 4.3.5** attributes the dispersal of about 65 percent of the volume of a spill to the use of dispersants. No calculation has been made to estimate how much oil might be deposited on a beach if dispersants are not used. Unfavorable winds and currents would further diminish the volume of oil that might contact a beach. A persistent, northwesterly wind might preclude contact. As discussed in **Chapters 3.2.1.1, 4.2.1.1.3.1, 4.2.2.1.3.1, and 4.3.1.8**, the probability that tide levels could reach or exceed the elevations of sand dune vegetation on barrier beaches ranges from 0 to 16 percent, depending on the particular coastal setting and the elevation of the vegetation. The strong winds that would be needed to produce unusually high tide levels would also disperse the slick over a larger area than is being considered in the current analysis. The probabilities of spill occurrence and contact to barrier beaches, and sand-dune vegetation are considered very low. Hence, contact of sand-dune vegetation by spilled oil is not expected to occur. Furthermore, the Mississippi River discharge would help breakup a slick that might otherwise contact Plaquemines Parish. The spreading would reduce the oil concentrations contacting the beach and vegetation, greatly reducing impacts on vegetation.

The barrier beaches of Deltaic Louisiana have the greatest rates of erosion and landward retreat of any known in the western hemisphere, and among the greatest rates on earth. Long-term impacts to contacted beaches from these spills could occur if significant volumes of sand were removed during cleanup operations. Removing sand from the coastal littoral environment, particularly in the sand-starved transgressive setting of coastal Louisiana, could result in accelerated coastal erosion. Spill cleanup is difficult in the inaccessible setting of coastal Louisiana. This analysis assumes that Louisiana would require the responsible party to clean the beach without removing significant volumes of sand or to replace the sand removed. Hence, cleanup operations are not expected to cause permanent effects on barrier beach stability. Within a few months, adjustments in beach configuration may result from the disturbance and movement of sand during cleanup.

The results of an investigation on the effects of the disposal of oiled sand on dune vegetation in Texas, showed no deleterious impacts on existing vegetation or colonization of the sand by new vegetation (Webb, 1988). Hence, projected oil contacts to small areas of lower elevation sand dunes are not expected to result in destabilization of the sand dune area or the barrier landform.

Some oil will penetrate to depths beneath the reach of the cleanup methods. The remaining oil would persist in beach sands, periodically being released when storms and high tides resuspend or flush through beach sediments. During hot, sunny days, tarballs buried near the surface of the beach sand may liquefy and cause a seep to the sand surface. The long-term stressors, including physical effects and chemical toxicity of hydrocarbons, may lead to decreased primary production, plant dieback, and hence further erosion (Ko and Day, 2004).

Pipeline Landfalls

Many of the existing OCS-related and other pipeline landfalls have occurred on barrier landforms (**Table 3-38** and **Chapter 3.3.5.8.8**). Construction of 32-47 new pipeline landfalls is expected as a result of the OCS Program (**Table 4-9** and **Chapter 4.1.2.1.7**). An MMS study and other studies (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988; Baumann and Turner, 1990; Day et al., 2000; Boesch et al., 1994) have investigated the geological, hydrological, and botanical impacts of pipeline construction on and under barrier landforms in the Gulf. In general, the impacts of existing pipeline landfalls since 1975 were minor to nonexistent with current installation methods. In most cases, no evidence of accelerated erosion was noted in the vicinity of the canal crossings if no shore protection for the pipeline was installed on the beach and if no remnant of a canal remained landward of the beach. Wicker et al. (1989) warn that the potential for future breaching of the shoreline remains at the sites of flotation canal crossings where island width is small or diminishing because of erosion or the sediments beneath the sand-shell beach plugs are unconsolidated and susceptible to erosion.

Numerous pipelines have been installed on the bay side of barrier islands and parallel to the barrier beach. With overwash and shoreline retreat, many of these pipeline canals serve as sediment sinks, resulting in narrowing and lowering of barrier islands and their dunes and beaches. Such islands and beaches were rendered more susceptible to breaching and overwash. While this type of pipeline placement is no longer used, the effects of the previous actions will continue to add to the cumulative impacts on coastal barrier beaches and islands.

An area of special concern along the south Texas coast is the Padre Island National Seashore, which is in EIA TX-1. At present, one OCS pipeline, which carries some condensate, crosses the northern end of Padre Island. For 2007-2046, 6-8 new pipeline landfalls are projected for Texas.

At present, trenchless, or directional drilling, is a more often required technique in sensitive habitats. Impacts from this technique are limited to the access and staging sites for the equipment. This method has been used successfully to place pipelines under scenic rivers so as not to disturb the bottom water or impact the banks of the river, as well as to traverse busy navigation canals without interrupting traffic. Few new OCS pipelines come ashore directly but rather link up to previously existing pipelines that already make landfall; thus, no landfall or onshore pipeline construction will result in most cases. Since 2002, only one new pipeline (Endymion oil pipeline) has come to shore in Louisiana from OCS-related activities. The 30-in Endymion Oil Pipeline delivers crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field. Based on a review of the data in the COE permit application (No. 20-020-1632), the emplacement of the pipeline caused zero (0) impacts to marshes (emergent wetlands) and beaches because the operator used horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the pipeline route maximized an open-water route to the extent possible. A comparison of aerial photos taken before and after Hurricanes Katrina and Rita reveal no observable landloss or impacts associated with the Endymion Oil Pipeline.

There are 0-1 gas processing plants and 0-1 pipeline landfalls projected in support of a proposed action in the WPA and a proposed action in the CPA. These activities are not expected to cause significant impacts to barrier beaches because of the use of non-intrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. The WPA and CPA proposed actions may contribute to the continued use of such facilities.

Vessel Traffic and Navigation Channels

The contribution of the OCS Program to vessel traffic in navigation channels is described in **Chapters 3.3.3.8.1 and 4.1.1.8.4.** A portion of the impacts attributable to maintenance dredging and wake erosion of those channels would be in support of the OCS Program. Mitigative measures are assumed to occur, where practicable, in accordance with Executive Order 11990 (May 24, 1977). During the 40-year analysis period, beneficial use of dredged material may increase, thereby reducing the continuing impacts of navigation channels and jetties.

No new navigation channels between the Gulf and inland regions are projected for installation. The basis of this assumption is the large number of existing navigation channels that can accommodate additional navigation needs. Some new inland navigation channels will be dredged to accommodate the inland oil and gas industry, developers, and transportation interests. Some channels may be deepened or widened to accommodate projected increases in deeper-draft petroleum production and larger cargo vessels that are not related to OCS petroleum production.

Existing channels will continue to create large sediment sinks that remove beach-quality sand from the littoral system. Long jetties protecting the channels can compartmentalize the coast, disrupting the flow of littoral drift and preventing the exchange of sand between adjacent coastal compartments (Morton, 2003). The result is accelerated landloss through locally enhanced erosive forces, increased water levels, and decreased sediment supply.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which, combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

Recreation and Tourism

Most barrier beaches in the CPA are relatively inaccessible for recreational use because they are either located a substantial distance offshore, as in Mississippi, or in coastal areas with limited road access, as in Louisiana. Few beaches in the CPA have been, or are likely to be, substantially altered to accommodate recreational or industrial construction projects in the near future.

Most barrier beaches in Texas, Alabama, and Florida are accessible to people for recreational use because of road access and their use is encouraged. The Texas Open Beaches Act (1959) guarantees the public's right to unimpeded use of the State's beaches. It also provides for public acquisition of private beach-front property. Recreational use of barrier beaches and dunes can have impacts on the stability of the landform. Vehicle and pedestrian traffic on sand dunes can stress and reduce the density of vegetation that binds the sediment and stabilizes the dune. Destabilized dunes are more easily eroded by winds waves and traffic. Judd et al. (1988) documented that as much as 18 percent of the total dune area along parts of South Padre Island had experienced damage from vehicular traffic. Recreational vehicles and even hikers have been problems where road access is available and where the beach is wide enough to support vehicle use, as in Texas, Alabama, Florida, and a few places in Louisiana. Areas without road access will have very limited impacts by recreational vehicles.

Summary and Conclusion

River channelization, sediment deprivation, tropical and extra-tropical storm activity, sea-level rise, and rapid submergence have resulted in severe, rapid erosion of most of the barrier and shoreline landforms along the Louisiana coast. The barrier system of coastal Mississippi and Alabama is well supported on a coastal barrier platform of sand. The Texas coast has experienced landloss because of a decrease in the volume of sediment delivered to the coast because of dams on coastal rivers, a natural decrease in sediment supply as a result of climatic changes during the past several thousand years, and subsidence along the coast.

Beach stabilization projects are considered by coastal geomorphologists and engineers to accelerate coastal erosion. Beneficial use of maintenance dredged materials could be required to mitigate some of these impacts.

The impacts of oil spills from both OCS and non-OCS sources to the sand-starved Louisiana coast should not result in long-term alteration of landform if the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes. The barrier beaches of deltaic Louisiana, the Chenier Plain, and the region around Galveston have the greatest risks of sustaining impacts from oil-spill landfalls because of their very high concentrations of oil production within 50 km (31 mi) of those coasts. The cleanup impacts of these spills could result in short-term (up to 2 years) adjustment in beach profiles and configurations as a result of sand removal and disturbance during cleanup operations. Some contact to lower areas of sand dunes is expected. These contacts would not result in significant destabilization of the dunes. The long-term stressors to barrier beach communities caused by the physical effects and chemical toxicity of an oil spill may lead to decreased primary production, plant dieback, and hence further erosion.

Under the cumulative scenario, new OCS-related and non-OCS pipeline landfalls are projected. These pipelines are expected to be installed using modern techniques, which cause little to no impacts to the barrier islands and beaches. Existing pipelines, in particular those that are parallel and landward of beaches, that had been placed on barrier islands using older techniques that left canals or shore protection structures have caused and will continue to cause barrier beaches to narrow and breach.

Recreational use of many barrier beaches in the Western Gulf is intense because of their accessibility by road. Because of the inaccessibility of most of the Central Gulf barrier coast to humans, recreational use is not expected to result in significant impacts to most beaches. Federal, State, and local governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines.

In conclusion, coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. Natural processes are generally considered the major contributor to these impacts, whereas human activities cause both severe local impacts as well as the acceleration of natural processes that deteriorate coastal barriers. Human activities that have caused the greatest adverse impacts are river channelization and damming, pipeline canals, navigation channel stabilization and maintenance, and beach stabilization structures. Deterioration of Gulf barrier beaches is expected to continue in the future. Federal, Louisiana, and parish governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines.

A proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which would accelerate erosion in those areas. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas. Thus, the incremental contribution of a proposed action to the cumulative impacts on coastal barrier beaches and dunes is expected to be very small.

4.5.3.2. Wetlands

This cumulative analysis for the WPA and CPA considers the effects of impact-producing factors related to a proposed action, prior and future OCS sales, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may occur and adversely affect wetlands. As a result of these activities and processes, several impact-producing factors, discussed below, will contribute to impacts on wetlands and associated habitat during the life of the proposed actions. The effects of pipelines, canal dredging, navigation activities, and oil spills on wetlands are described in **Chapters 4.2.1.1.3.2, 4.2.2.1.3.2, and 4.4.3.2**. Subsidence of wetlands is discussed in more detail in **Chapter 4.1.3.3.1**. Other impact-producing factors and information relevant to the cumulative analysis are discussed below.

River Channelization and Damming

Many of man's activities have resulted in landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900's, floodwaters layered sediment over the active Deltaic plain, countering ongoing submergence and also building new land. Areas that did not receive sediment-laden floodwaters continually lost elevation. Human intervention has interrupted the process of renewal. Further compounding this impact, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, natural drainage patterns along many areas of the Texas coast have been severely altered by construction of the GIWW and other channelization projects associated with its development. Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (Tiner, 1984; National Wetlands Inventory Group, 1985; Cox et al., 1997). Productivity and species diversity associated with wetlands and submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989; Cox et al., 1997).

Wetland loss rates in coastal Louisiana are well documented to have been as high as 10,878 ha/yr (42 mi^2/yr) during the late 1960's. Studies have shown that the landloss rate in coastal Louisiana for the period 1972-1990 slowed to between an estimated 6,475 ha/yr (25 mi^2/yr) (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993) and 9,072 ha/yr (35 mi^2/yr) (USDOI, GS, 1998). It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 2,672 ha/year (10 mi^2/yr) over the next 50 years. Further, it was estimated that an additional net loss of 132,794 ha (512 mi^2) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al., 2003). However, in 2005 Hurricanes Katrina and Rita caused 217 mi^2 of land change (primarily wetlands to open water) (Barras, 2006). The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and shifted the coastal area from a condition of net land building to one of net landloss (USACOE, 2004c).

Development of Wetlands

Development of wetlands for agricultural, residential, and commercial uses affects coastal wetlands. During the period 1952-1974 in the Chenier Plain area of southwestern Louisiana, an estimated 1,233 ha (3,047 ac) of wetlands were converted to urban use (Gosselink et al., 1979). During the period 1956-1978, an estimated 53,479 ac (21,642 ha) of urban or industrial development occurred in the Mississippi Deltaic Plain region of southern Louisiana (Bahr and Wascom, 1984). Submergence rates in coastal Louisiana have ranged from 0.48 to 1.3 cm (0.19 to 0.51 in) per year (Baumann, 1980; Ramsey et al., 1991). This submergence is primarily due to subsidence due to the elimination of river flooding. Flooding normally deposited sediment over the delta plains, which either slowed subsidence, maintained land elevations, or built higher land elevations, depending upon the distances from the river and the regularity of flooding for each region of interest. Recently, Tornqvist et al. (2006) studied three areas in coastal southeastern Louisiana and found that, while the areas are experiencing rapid wetland loss, the areas are surprisingly tectonically stable. The findings imply that the rapid wetland loss in coastal Louisiana is due in large part to compaction of Holocene strata (the rocks and deposits from 10,000 years ago to present), as well as human factors such as onshore oil and gas extraction, groundwater extraction, drainage of wetland soils, and burdens placed by buildings roads and levees.

Areas of local subsidence have also been correlated to the past extraction of large volumes of underground resources including oil, gas, water, sulfur, and salt (Morton, 2003; Morton et al., 2002; Morton et al., 2005). Along coastal Louisiana, high historical subsidence rates, up to 23 mm/yr (1 in/yr), were found to correspond with reactivated fault zones and oil and gas fields during the highest rates of fluid production between the 1950's and 1970's. Subsidence induced by fluid withdrawal is an irreversible process because it involves sediment compaction and dewatering of interbedded clays.

Reservoirs also contribute to wetlands loss by regulating river discharge and sediment load to downstream deltas and beaches. The most extensive control of a river system in the U.S. is the confinement of the Mississippi River and the prevention of it switching into the Atchafalaya River.

Oil and Chemical Spills

Wetland contacts by oil and chemical spills can occur from a number of sources. **Chapter 4.1.3.4** provides an estimate of future spill risk. Their projected effects on wetlands are described in **Chapter 4.4.3.2**. The cumulative scenario discusses petroleum and products spills from all sources, inclusive of the OCS Program, imports, and State production. The large majority of oil slicks that contact land are expected to come ashore on barrier islands. Offshore spills from non-OCS sources are assumed to display similar spill dispersion and weathering characteristics to that of OCS-related spills.

Flood tides may bring some oil through tidal inlets into areas landward of barrier beaches. The turbulence of tidal water passing through most tidal passes would break up the slick, thereby accelerating dispersion and weathering. For the majority of these situations, light oiling of vegetated wetlands may occur, contributing less than 0.1 l/m^2 on wetland surfaces. Any adverse impacts that may occur to wetland plants are expected to be very short lived, probably less than one year.

Coastal OCS spills could occur as a result of pipeline accidents and barge or shuttle tanker accidents during transit or off-loading. The frequency, size, and distribution of all coastal spills are provided in **Chapter 4.1.3.4**. Impacts of OCS coastal spills are also discussed in **Chapter 4.3.1.6**. Non-OCS spills can occur in coastal regions as a result of import tankers, coastal oil production activities, and petroleum product transfer accidents. Their distribution is believed to be similar to that described in **Chapter 4.3.1.**

Numerous wetland areas have declined or have been destroyed as a result of oil spills caused by pipeline breaks or tanker accidents. The oil stresses the wetland communities, making them more susceptible to saltwater intrusion, drought, disease, and other stressors (Ko and Day, 2004). Spills that occur in or near Chandeleur or Mississippi Sounds could potentially impact wetland habitat in or near the Gulf Islands National Seashore and the Breton National Wildlife Refuge and Wilderness Area. Because of their natural history, these areas are considered areas of special importance, and they support endangered and threatened species. Although the wetland acreage on these islands is small, the wetlands make up an important element in the habitat of the islands. This area was severely impacted by Hurricane Katrina in August 2005. Because the inlets that connect Mississippi Sound with the marsh-fringed estuaries and lagoons within the islands are narrow, a small percentage of the oil that contacts the Sound side of the islands will be carried by the tides into interior lagoons.

The past discharge of saltwater and drilling fluids associated with oil and gas development has been responsible for the decline or death of some marshes (Morton, 2003). Discharging OCS-related produced water into inshore waters has been discontinued and all OCS-produced waters transported to shore will either be injected or disposed of in Gulf waters and will not affect coastal wetlands (**Chapter 4.1.1.4.2**).

Pipelines

Pipeline construction and maintenance has affected wetlands in a number of ways. Modern pipeline installation methods and impacts are described in **Chapters 4.1.1.8.1 and 4.1.2.1.7**. The State oil and gas industry is generally described in **Chapter 3.3.5.9**. The majority of OCS pipelines entering state waters tie into existing pipeline systems, and do not result in new landfalls. Thus, of the 80-118 new OCS pipelines projected to enter state waters, only 32-47 would be expected to result in new landfalls. Landfalls are expected to be constructed using modern trenchless methods and employ modern mitigation techniques resulting in zero (0) to negligible impacts to wetland habitats. The permitting and mitigation process is run by COE and the State of Louisiana. Pipeline maintenance activities that disturb wetlands are very infrequent and are mitigated to the extent practicable.

Existing OCS and non-OCS related pipelines are expected to continue to adversely impact coastal wetlands. The majority (over 80%) of OCS-related direct landloss is estimated to be from OCS pipelines (Turner and Cahoun, 1988). Such impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment transport, and habitat conversion (Cox et al., 1997; Morton, 2003; Ko and Day, 2004). Since the beginning of OCS activities in the GOM, approximately 15,400 km (9,563 mi) of OCS pipelines have been constructed in Louisiana seaward of the inland CZM boundary to the 3-mi State/Federal boundary offshore. Of those pipelines, about 8,000 km (4,971 mi) cross wetland and upland habitat. The remaining 7,400 km (4,595 mi) cross waterbodies (Johnston and Cahoon, in preparation). The total length of non-OCS pipelines through wetlands is believed to be approximately twice that of the Gulf OCS Program, or about 15,285 km (9,492 mi) for a total of approximately 23,285 km (14,460 mi) of pipelines through Louisiana coastal wetlands. Sources of pipeline data include Penn Well Mapsearch, MMS, Nation Pipeline Mapping System, and the Geological Survey of Louisiana pipeline datasets. Based on the preliminary findings of the Johnston and Cahoon (in preparation), the following landloss data is presented (based on USGS landloss data from 1956 to 2002):

- total amount of landloss attributable to OCS pipelines is 34,400 ha (86,000 ac);
- landloss is about 0.04 km^2 (4.00 ha or 9.88 ac) per linear km of pipeline installed; and
- approximately 11.9 percent of Louisiana coastal wetland landloss is attributable to OCS pipelines.

The widening of OCS pipeline canals does not appear to be an important factor contributing to OCS-related direct landloss. This is because few pipelines are open to navigation, and the impact width does not appear to be significantly different than that for open pipelines closed to navigation. As a result of the OCS Program (2007-2046), up to 64-94 km (40-58 mi) of onshore pipeline are projected to be constructed in the WPA and CPA. Based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss (based on an average of 4 ha (9 ac) of conversion to open water per linear km of pipeline (300-m buffer zone)) from the estimated 64-94 km (40-58 mi) of new OCS pipeline construction ranges from approximately 256-376 ha (633-929 ac) total over the 40-year analysis period. Based on the projected coastal Louisiana wetlands loss of 132,607 ha (327,679 ac) for the years 2000-2040 (Barras et al., 2003), this represents about 0.2 percent of the total expected wetlands loss for that time period. This estimate does not take into account the present regulatory programs of the COE and Louisiana DNR, modern installation techniques, and “no net loss” policy, which would result in zero (0) to negligible impacts to wetland habitats.

The WPA Lease Sale 200, held in August 2006, is projected to result in 320-640 km (199-398 mi) of new offshore pipelines installed, a small addition to the 56,327 km (35,000 mi) of pipelines currently found within the GOM. These pipelines will most likely tie in with other offshore pipelines. Zero to 1 pipeline landfall, resulting in up to 2 km (1 mi) of new pipeline, is projected to come ashore in Texas, along a pipeline corridor route that is already well established. Effects from a single landfall will be negligible since modern state-of-the-art construction techniques and protective mitigations will be used (see **Chapter 3.3.5.8.8**, Coastal Pipelines).

As stated in **Chapter 4.1.3.1.2**, State Pipeline Infrastructure, the existing pipeline network in the Gulf Coast States is developed and extensive with spare capacity. Expansion is projected to be primarily small-diameter pipelines to increase the interconnectivity of the existing network and a few major interstate pipeline expansions.

Dredging

Most canals dredged in coastal Louisiana and Texas have occurred as a result of onshore oil and gas activities. Drilling and production activity at most coastal well sites in Louisiana and Texas require rig access canals. Access canals and pipelines to service onshore development are pervasive throughout the coastal area in Louisiana; 15,285 km (9,498 mi) of pipeline canals have been installed to carry onshore production (USDOI, GS, 1984). Typical dimensions of an access canal, as indicated on permits during 1988, were 366-m (1,201 ft) long by 20-m (66-ft) wide with a 0.5-ha (1.2-ac) drill slip at the end. Assuming loss of 4.00 ha (9.88 ac) per linear km, the total direct wetlands loss as a result of onshore oil and gas activities is 61,140 ha (151,000 ac).

Navigation Channels and Canals

As discussed in **Chapter 4.1.1**, the magnitude of future OCS activities is being directed towards deeper water, which may require larger service vessels for efficient operations. Ports housing OCS-related service bases that can accommodate deeper-water vessels are described in **Chapter 4.1.2.1.1**. Empire and Cameron, Louisiana, are considered marginally useable for OCS-related, shallow water traffic.

Ports containing service bases with access channels less than 4.5 m (15 ft) deep may decide to deepen their channels to capture portions of OCS activities projected for deep water. Typically, channels greater than 6-7 m deep will not be needed to accommodate the deepwater needs of the OCS Program. Channels deeper than 6-7 m accommodate increasing numbers of ocean-going ships. The Corpus Christi, Houston, and Mississippi River ship channels are being considered for deepening to allow access by larger ocean-going vessels that are not related to the OCS Program. Since the Port Authority of Lafourche Parish and the COE have deepened access and interior channels of Port Fourchon to greater than 7 m NGVD, the numbers of cargo vessels not related to petroleum or fishing using Port Fourchon are projected to increase in the future. Increased population and commercial pressures on the Mississippi Gulf Coast are also causing pressures to expand ports there.

Materials dredged to deepen channels in Port Fourchon are expected to be placed to create development sites and 192 ha (474 ac) of saline marsh. The feasibility report anticipates no significant saltwater intrusion effects on wetlands as a result of the deepening project, probably because the project only extends approximately 8.5 km (5.2 mi) inland and will be performed in a saline environment where the existing vegetation is salt tolerant (**Chapters 4.2.1.1.3.2, 4.2.2.1.3.2, and 4.4.3.2**).

Deepening the Corpus Christi Ship Channel from -13.7 to -15.2 m NGVD is expected to displace approximately 353 million m^3 in an open bay system. The recent dredging and deepening of this channel to -13.7 m NGVD caused no significant saltwater intrusion. The dredged material generated by the deepening project will be used to enhance and create wetlands rather than be disposed of onto spoil banks adjacent to the channel. No significant adverse impacts to wetlands are expected to result from the project.

Vessel traffic within navigation channels can cause channel bank erosion in wetland areas. **Table 3-36** shows vessel traffic using OCS-related waterways in 2004. Approximately 12 percent of the traffic using OCS-related channels is related to the OCS Program. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr (4.9 ft/yr). Much of the length of these channels is through eroding canals, rivers, and bayous. Non-OCS-related navigation channels are believed to conduct lower traffic volumes and, therefore are expected to widen at a lower rate of as much as 0.95 m/yr (3.12 ft/yr). Assuming the 2,000 km (1,243 mi) of OCS-related navigation channels continue to erode at 1.5 m/yr (4.9 ft/yr), then about 11,700 ha (28,911 ac) of wetlands loss would occur over the period 2007-2046. Of this, 12 percent, or 1,400 ha, would be attributable to the OCS Program. About 81 percent of the total direct wetland loss resulting from navigation channels is caused by the MRGO, Calcasieu Ship Channel, and Beaumont Channel/Sabine Pass, all of which have very low OCS destination usage (Turner and Cahoun, 1988).

Maintenance dredging of existing channels will occur and could harm wetlands if the dredged material is deposited onto wetlands, resulting in burial or impoundment of marsh areas. Current practice makes use of dredged material for wetland enhancement and creation during the life of a proposed action. Ten percent of associated maintenance dredging of OCS-related channels and related impacts are attributed to the OCS Program. On average, every two years the four COE Districts survey the navigation channels they are responsible for to determine the need for maintenance dredging. Schedules for maintenance dredging of OCS-related navigation channels vary broadly from once per year to once every 17 years. Each navigation channel is typically divided into segments called "reaches." Each reach may have a maintenance schedule that is independent of adjacent reaches. COE data indicates an approximate average of 14,059,500 m^3 per year or 492,082,500 m^3 per 35 years are displaced by maintenance dredging activities on OCS-related navigation channels in the Gulf area; this roughly amounts to approximately 144,700 m^3 per kilometer.

Navigation channels not used by OCS navigation traffic are generally smaller, less-used channels with less frequent maintenance dredging. These channels are expected to produce 50 percent less maintenance-dredged materials per km. Maintenance dredging of non-OCS-related channels is estimated to produce approximately 36,576,500 m^3 of material during the period 2007-2046. This dredged material could be used to enhance or re-establish marsh growth in deteriorating wetland areas. If implemented, the damaging effects of maintenance dredging of navigation channels would be reduced.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks. Over 80 percent of the total, direct wetland loss resulting from navigation channels is caused by the MRGO, Calcasieu Ship Channel, and Beaumont Channel/Sabine Pass, all of which have very low OCS destination usage (Turner and Cahoun, 1988).

Significant volumes of OCS-related produced sands and drilling fluids will be transported to shore for disposal. According to USEPA information, sufficient disposal capacity exists at operating and proposed disposal sites. Economic and political opportunities exist that may support construction of new disposal sites. Because of current regulatory policies, no wetland areas will be disturbed as a result of the establishment of new disposal sites or expansions or existing sites, without adequate mitigation. Some seepage from waste sites may occur into adjacent wetland areas and result in damage to wetland vegetation.

Other miscellaneous factors that impact coastal wetlands include marsh burning and marsh buggy traffic. Bahr and Wascom (1984) report major marsh burns that have resulted in permanent wetland loss. Sikora et al. (1983) reported that in one 16-km^2 (6-mi^2) wetland area in coastal Louisiana, 18.5 percent of the area was covered with marsh-buggy tracks. Tracks left by marsh buggies have been known to open new routes of water flow through relatively unbroken marsh, thereby inducing and accelerating erosion and sediment export. Marsh-buggy tracks are known to persist in Louisiana intermediate, brackish, and saline marshes for 15-30 years.

Current Mitigation Techniques Used to Reduce Adverse Impacts to Wetlands

Numerous regulatory mechanisms, combined with a well-defined mitigation process, are used for wetland protection. The Clean Water Act's Section 404 dredge and fill permit program is the strongest regulatory tool protecting wetlands from impacts; however, the key component of Section 404 is the requirement that adverse ecological impacts of a development project be mitigated by the developing agency (for OCS pipeline landfalls, this is the Corps of Engineers) or individual. The core of wetland protection requirements revolves around the ability to mitigate or minimize impacts to wetlands and other sensitive coastal habitat.

Mitigation or the minimization of wetland impacts is particularly relevant along the northern coast of the GOM, specifically Louisiana, where significant impacts from human activities related to the oil and gas industry occur in wetland systems. As researchers document the direct and indirect consequences of pipelines canals, dredging, and dredged material placement on wetland systems, optimizing old mitigation techniques and identifying new mitigation techniques in order to reduce impacts as much as possible is a necessary component of any development plan that terminates onshore. With more than 16,000 km (about 10,000 mi) of OCS-related pipelines along the coast of the northern GOM (Johnson and Cahoon, in review), and the extent to which activities related to these pipelines and any new pipelines are mitigated, may be crucially important to the long-term integrity of the sensitive habitats (i.e., wetlands, shorelines, and seagrass communities) in these sensitive and fragile areas.

The following information identifies and documents the use and effectiveness of mitigation techniques related to OCS pipelines, canals, dredging, and dredged material placement in coastal habitats along the northern coast of the GOM and associated with the proposed action. The material provides an overview and discussion of mitigation techniques that have been studied and used, as well as new and newly modified mitigation techniques that may not be well documented.

Mitigation Defined

The Council on Environmental Quality (1978) defined mitigation as a five-step process.

(1) Avoidance—the avoiding of the impact altogether by not taking a certain action or part of an action

(2) Minimization—the minimizing of impacts by limiting the degree or magnitude of the action and its implementation

(3) Restoration—the rectifying of the impact by repairing, rehabilitating, or restoring the affected environment

(4) Preservation through Maintenance—the reducing or eliminating of the impact over time by preservation and maintenance operations during the life of the action

(5) Compensation—the compensating for the impact by replacing or providing substitute resources of environments

Mitigation History Related to Oil and Gas Activities

Mitigation of wetland impacts from oil and gas activities has a very short history. Prior to the 1980's, wetlands were not protected and very little attention was paid to the environmental impacts of pipeline construction within wetland areas. Focus was on deciding the best (fastest and most economical) way to install the pipelines in soft sediment. With more recent requirements for considering impacts to sensitive coastal habitat, methods and techniques for mitigation impacts have developed and refined.

Because of the extensive coastal wetland systems along the northern coast of the GOM, avoidance of wetland systems is often impossible for pipelines related to OCS activities. Thus, minimization is the main focus of mitigation for pipeline-related activities. Numerous suggestions for minimization impacts have been recommended with some of the most promising ideas emerging based on past experience and field observations.

Overview of Existing Mitigation Techniques and Results

Numerous mitigation methods have been recommended and used in the field. Depending on the location, the project in question, and the surrounding environment, different mitigation techniques may be more appropriate over another. Based on permits, work documents, and interviews, 17 mitigation techniques have been implemented at least once, with no one technique or suite of techniques routinely required by permitting agencies; each pipeline mitigation process is uniquely designed to minimize damages given the particular setting and equipment to be installed. Of the identified mitigation techniques, there are, however, a number of techniques that are commonly required, while others are rarely used either because they are considered obsolete in most instances or because they are applicable only to a narrow range of settings. **Table 4-42** highlights and summarizes technical evidence for the use of various mitigating processes associated with pipeline construction, canals, dredging, and dredged material placement.

Sources of Available Funding for Wetland Restoration

In fiscal year 2001, the Coastal Impact Assistance Program (CIAP) was authorized by Congress to assist states in mitigating the impacts associated with OCS oil and gas production. Congress appropriated approximately $150 million to NOAA to be allocated to seven coastal states—Alabama, Alaska, California, Florida, Louisiana, Mississippi, and Texas. Under CIAP, NOAA administered more than 150 separate grants to States and localities. The CIAP funded more than 600 projects including habitat protection and restoration, land acquisition, and water quality improvement projects (USDOC, NOAA, 2006). Under the Energy Policy Act of 2005, Congress reauthorized CIAP, which is now administered by MMS (**Chapter 1.3**). Under Section 384 of the Energy Policy Act, MMS shall disburse $250 million for each fiscal year 2007 through 2010 to eligible producing States and coastal political subdivisions.

There are numerous other funding options available for coastal restoration and planning efforts across the Gulf Coast, including the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA); National Coastal Restoration Grant Program; Coastal and Estuarine Land Conservation Program; Coastal Wetlands Partnership; Coastal Erosion Planning and Response Act (CEPRA); NOAA Community-based Restoration Program; Gulf Ecological Management Site (GEMS); North American Wetlands Conservation Act (NAWCA); and EPA Gulf of Mexico Program. However, a lack of matching dollars for the Federal monies and people to run the projects are often problematic. Several entities, such as the National Fish and Wildlife Foundation and Coastal America's Coastal Wetlands Restoration Partnership, have been created to leverage the Federal funds or to provide financial assistance for projects coming up short on funding. Other entities, such as the Gulf of Mexico Foundation, have been formed with the express purpose of facilitating access to funding sources that organizations and agencies could not easily interact with (see also **Chapter 4.1.3.3.4**, Coastal Restoration).

Summary and Conclusion

Impacts from residential, commercial, and agricultural and silvicultural (forest expansion) developments are expected to continue in coastal regions around the Gulf. Existing regulations and development permitting procedures indicate that development-related wetland loss may be slowed and that very few new onshore OCS facilities, other than pipelines, will be constructed in wetlands.

Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals, maintenance and usage of existing rig access canals and drill slips, and preparation of new well sites. Locally, subsidence may be due to extraction of large volumes of oil and gas from subsurface reservoirs, although subsidence associated with this factor seems to have slowed greatly over the last three decades as the reservoirs are depleted. Indirect impacts from dredging new canals for State onshore oil and gas development (**Chapter 4.1.3.3.3**) and from maintenance of the existing canal network is expected to continue.

Maintenance dredging of the OCS-related navigation channels displaces approximately 492,082,500 m^3, of which 10 percent is attributed to the OCS Program. Federally maintained, non-OCS-related navigation channels are estimated to account for another estimated 36,576,500 m^3 of dredged material. Maintenance dredging of inshore, well-access canals is estimated to result in the displacement of another 5,014,300 m^3 of materials. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed upon existing disposal areas. Alternative dredged material disposal methods can be used to enhance and create coastal wetlands.

Depending upon the regions and soils through which they were dredged, secondary adverse impacts of canals may be more locally significant than direct impacts. Additional wetland losses generated by the secondary impacts of saltwater intrusion, flank subsidence, freshwater-reservoir reduction, and deeper tidal penetration have not been calculated due to a lack of quantitative documentation; the MMS has initiated a project to document and develop data concerning such losses. A variety of mitigation efforts are initiated to protect against direct and indirect wetland loss. The non-maintenance of mitigation structures that reduce canal construction impacts can have substantial impacts upon wetlands. These localized impacts are expected to continue.

Various estimates of the total, relative direct and indirect impacts of pipeline and navigation canals on wetland loss vary enormously; they range from a low of 9 percent (Britsch and Dunbar 1993) to 33 percent (Penland et al., 2001a and b) to estimates of greater than 50 percent (Turner et al., 1982; Bass and Turner, 1997; Scaife et al., 1983). A panel review of scientific evidence suggests that wetland losses directly attributable to all human activities account for less than 12 percent of the total wetland loss experienced since 1930 and approximately 29 percent of the total losses between 1955 and 1978 (Boesch et al., 1994). Of these direct losses, 33 percent are attributed to canal and spoil bank creation (10% of overall wetland loss).

In Louisiana, deepening Fourchon Channel to accommodate larger, OCS-related service vessels has occurred within a saline marsh environment and will afford the opportunity for the creation of wetlands with the dredged materials. Also, deepening the Corpus Christi and Houston Ship Channels is non-OCS-related and should also afford the opportunity to create wetlands with dredged material. A variety of non-OCS-related pressures are generating a need to expand ports on the Mississippi Gulf Coast.

In conclusion, based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss from the estimated 64-94 km (40-58 mi) of new OCS pipeline construction ranges from approximately 256-376 ha (633-929 ac) total over the 40-year analysis period. This estimate does not take into account the current regulatory programs, modern construction techniques and mitigations, or any new techniques that might be developed in the future. The modern construction techniques and mitigative measures result in zero (0) to negligible impacts on wetland habitats. The current MMS/USGS pipeline study is continuing to develop models that will aid in quantifying habitat loss associated with OCS activities. The WPA and CPA proposed actions represent about 1 and 3-4 percent, respectively, of the OCS impacts that will occur during the period 2007-2046. The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and shifted the coastal area from a condition of net land building to one of net landloss. Deltaic Louisiana is expected to continue to experience the greatest loss of wetland habitat. Wetland loss is also expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates.

The incremental contribution of any single proposed action or any single recent lease sale (such as Western GOM Lease Sale 200) to the cumulative impacts on coastal wetlands is expected to be very small. The primary impacting factors attributable to a proposed action are pipeline landfalls, canal widening, and maintenance dredging of navigation canals. Loss of 0-8 ha (0-20 ac) of wetlands habitat is estimated as a result of 0-2 km (0-1.2 mi) of new pipelines projected as a result of a proposed action. Secondary impacts from a proposed action to wetlands would be primarily from vessel traffic corridors and will continue to cause approximately 0.6 ha (1.5 ac) of landloss per year. However, effective mitigation and construction techniques have been and would be used to prevent or minimize landloss.

4.5.3.3. Seagrass Communities

This cumulative analysis considers the effects of impact-producing factors related to WPA and CPA proposed actions, prior and future OCS activities, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may adversely affect seagrass communities and associated habitat during the life of a proposed action. The cumulative effects of pipelines, canal dredging, scaring from vessel traffic, oil spills, and hurricanes on seagrass communities and associated habitat are described in **Chapters 4.2.1.1.3.3, 4.2.2.1.3.3, and 4.4.2.3.3**. In addition to the above stated impacts, other impact-producing factors (channelization) relevant to the cumulative analysis are discussed below.

Pipelines

Pipeline construction projects can affect seagrass habitats in a number of ways; however, maintenance activities that disturb wetlands and associated habitat (submerged vegetation and seagrass beds) are very infrequent and considered insignificant. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements for canal and pipeline construction. Pipeline installation methods and impacts to submerged vegetation are described in **Chapters 4.1.2.1.7 and 4.2.2.1.3.3**. The State oil and gas industry is generally described in **Chapter 4.1.3.1**. About 250 active OCS pipelines currently cross the Federal/State boundary into State waters, of which over 100 make landfall. There are 80-118 new pipelines projected in State waters as a result of the OCS Program from 2007 to 2046. Of those, 32-47 are projected to make landfall.

Dredging, Channelization, and Water Controls

Dredge and fill activities are the greatest threats to submerged vegetation and seagrass habitat (Wolfe et al., 1988). Existing and projected lengths of OCS-related pipelines and OCS-related dredging activities are described in **Chapters 4.1.2.17 and 4.1.3.3.3**. The dynamics of how these activities impact submerged vegetation is discussed in **Chapters 4.2.1.1.3.3 and 4.2.2.1.3.3**. The most serious impacts to submerged vegetation and associated seagrass communities generated by dredging activities are a result of removal of sediments, burial of existing habitat, and oxygen depletion and reduced light associated with increased turbidity. Turbidity is most damaging to beds in waterbodies that are enclosed, have relatively long flushing periods, and contain bottom sediments that are easily resuspended for long periods of time. An integrative model of seagrass distribution and productivity produced by Dunton et al. (1998) strongly suggests light attenuation due to dredging operations that increases turbidity will negatively impact seagrass health.

Dredging impacts associated with the installation of new navigation channels are greater than those for pipeline installations, because new canal dredging creates a much wider and deeper footprint. A greater amount of material and fine materials are disturbed; hence, turbidity in the vicinity of canal dredging is much greater, persists for longer periods of time, and the turbidity extends over greater distances and acreage. New canals and related disposal of dredged material also cause significant changes in regional hydrodynamics and associated erosion. Significant and substantial secondary impacts include wake erosion resulting from navigational traffic as evident along the Texas coast where heavy traffic utilizing the Gulf Intracoastal Waterway (GIWW) has accelerated erosion of existing salt marsh habitat (Cox et al., 1997). New canals can also encourage additional development.

Most impacts to lower-salinity species of submerged vegetation and seagrass communities by new channel dredging within the cumulative activity area have occurred in Louisiana and Texas. This will continue to be the case in the foreseeable future. Similarly, most impacts to higher-salinity species of submerged vegetation have occurred in Florida, where seagrass beds are more abundant. Reduction of submerged vegetation in the bays of Florida is largely attributed to increased turbidity, primarily due to dredge and fill activities (Wolfe et al., 1988). Channel dredging to facilitate, create, and maintain waterfront real estate, marinas, and waterways will continue to be a major impact-producing factor in the proposed cumulative activity area.

The waterway maintenance program of the COE has been operating in the cumulative activity area for decades (**Chapter 4.1.2.1.9**). Impacts generated by initial channel excavations are sustained by regular maintenance activities performed every 2-5 years, or perhaps less frequently. The patterns of submerged vegetation and seagrass beds have adjusted accordingly. Maintenance activities are projected to continue into the future regardless of the OCS activities. If the patterns of maintenance dredging change, then the patterns of submerged vegetation distribution may also change.

In areas where typical spoil banks are used to store dredged materials, the usual fluid nature of mud and subsequent erosion causes spoil bank widening, which may bury nearby waterbottoms and submerged vegetation/seagrass beds. Those waterbottoms may become elevated, converting some nonvegetated waterbottoms to shallower waterbottoms that may become vegetated due to increased light at the new soil surface. Some of these waterbottoms may also be converted to wetlands, or even uplands, by the increased elevation.

Plans for installation of new linear facilities and maintenance dredging are reviewed by a variety of Federal, State, and local agencies, as well as by the interested public for the purposes of receiving necessary government approvals. Mitigation may be required to reduce undesirable impacts. The most effective mitigation for direct impacts to seagrass beds and associated habitat is avoidance with a wide berth around them. Using turbidity curtains can also control turbidity.

Many of man’s activities have caused landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900’s, floodwaters layered sediment over the active Deltaic plain, countering ongoing submergence and also building new land. Areas that did not receive sediment-laden floodwaters continually lost elevation. Human intervention interrupted this process of renewal. Further compounding this impact, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950’s, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, natural drainage patterns along many areas of the Texas coast have been severely altered by construction of the GIWW and other channelization projects associated with its development. Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (including seagrass communities) (Tiner, 1984; National Wetlands Inventory Group, 1985). Productivity and species diversity associated with submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989).

Leveeing (or banking) and deepening of the Mississippi River has affected seagrass communities in the Mississippi and Chandeleur Sounds by reducing freshwater flows and flooding into those estuaries and by raising average salinities there. Due to increased salinities, some species of submerged vegetation including seagrass beds are able to populate areas farther inland, where sediment conditions are not as ideal. If the original beds are then subjected to salinities that are too high for their physiology, the vegetation will die which affects the habitat associated with the seagrass beds, e.g., nursery habitat for juvenile fish and shrimp. In turn, freshwater inflow increases around the mouths of rivers that have been modified for flood control, hence, beds of submerged vegetation may become established farther seaward if conditions are favorable. If the original beds are then subjected to salinities that are too low for their physiology, the vegetation will die. These adjustments have occurred in the cumulative activity area, particularly when high-water stages in the Mississippi River cause the opening of the Bonnet Carre Spillway to divert flood waters into Lake Pontchartrain. This freshwater eventually flows into Mississippi and Chandeleur Sounds, lowering salinities there. In the past, spillway openings have been associated with as much as a 16 percent loss in seagrass vegetation acreage (Eleuterius, 1987). Conversely, the Caernarvon Freshwater Diversion into the Breton Sound Basin, east of the River, provides more regular flooding events, which have reduced average salinities there. Reduced salinities there have triggered a large increase in acreage of submerged freshwater vegetation. Seagrass communities may then reestablish in regions that were previously too saline for them.

Scarring

The scarring of seagrass beds by vessels (including various support vessels for OCS and State oil and gas activities, fishing vessels, and recreational watercraft) is an increasing concern along the Texas coast. Scarring most commonly occurs in seagrass beds that occur in water depths shallower than 6 ft as a result of boats of all classes operating in water that is too shallow for them. Consequently, their propellers and occasionally their keels plow though shallow water bottoms, tearing up roots, rhizomes, and whole plants, leaving a furrow that is devoid of seagrasses ultimately destroying essential nursery habitat. Other causes include anchor drags, trawling, trampling, and loggerhead turtles (especially in seagrass habitat of the coast of Florida) (Sargent et al., 1995; Preen, 1996). Recently, seismic activity in areas supporting seagrass nursery habitat has become a focus of concern for Texas state agencies. Although the greatest scarring of seagrasses has resulted from smaller boats operating in the vicinities of the greatest human population and boat registration densities, the greatest single scars have resulted from commercial vessels. Scarring may have a more critical effect on habitat functions in areas with less submerged vegetation. A few local and state governments in the Coastal Bend area of Texas have instituted management programs to reduce scarring. These programs include education, channel marking, increased enforcement, and limited-motoring zones. Initial results indicate that scarring can be reduced.

Oil Spills

Because of the floating nature of oil and the regional microtidal range, oil spills alone would typically have very little impact on seagrass communities and associated epifauna. Increased wave action can increase impacts to submerged vegetation and the community of organisms that reside in these beds by forcing oil from the slick into the water column. Unusually low tidal events would also increase the risk of oil having direct contact with the vegetation. Even then, epifauna residing in these seagrass beds would be more heavily impacted than the vegetation itself. Oiling of seagrass beds would result in die-back of the vegetation and associated epifauna, which would be replaced for the most part in 1-2 growing seasons, depending upon the season in which the spill occurs. Although little or no direct mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude or refined oil products has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987). Cleanup of slicks in shallow, protected waters (less than 5 ft deep) can cause significant scarring and trampling of submerged vegetation beds.

Oil spilled in Federal offshore waters is not projected to significantly impact submerged aquatic vegetation, which includes seagrass communities. In contrast and based on information presented in **Chapter 4.1.3.4**, oil spills from inland oil-handling facilities and navigational traffic has a greater potential for impacting wetlands and seagrass communities. Given the large number of existing oil wells and pipelines in eastern coastal Louisiana and the volumes of oil piped through that area from the OCS, the risk of oil-spill contacts to the few seagrass beds in that vicinity would be much higher than elsewhere in the cumulative activity area.

Hurricanes

Seagrass beds have been repeatedly damaged by the natural processes of transgression from hurricane overwash of barrier islands. The Chandeleur Island chain has been hit by five storms in the past eight years; these include Hurricane Georges, Tropical Storm Isadore, Hurricane Ivan, Hurricane Lilli, and Hurricane Katrina (Michot and Wells, 2005). Storm-generated waves wash sand from the seaward side of the islands over the narrow islands and cut new passes through the islands. The overwashed sand buries seagrass beds on the back side of the islands. Cuts formed in the islands erode channels that remove seagrass in its path. Over time, seagrass recolonizes the new sand flats on the shoreward side, and the natural processes of sand movement rebuild the islands. Land mass rebuilt since Hurricane Ivan was washed away by Hurricane Katrina. The Chandeleur Islands were reduced by Hurricane Katrina from 5.64 mi^2 to 2.5 mi^2 (14.61 km^2 to 6.47 km^2) and then to 2.0 mi^2 (5.18 km^2) by Hurricane Rita (Di Silvestro, 2006).

Hurricane impacts can produce changes in seagrass community quality and composition. A survey of Alabama seagrass beds showed 86 percent remaining after Hurricane Ivan (Heck and Byron, 2006). Fluctuations in community composition were documented for Lake Pontchartrain in Louisiana following Hurricane Georges *(*Poirrier and Cho, 2002). Seagrasses in Bayou la Batre, Alabama, evidence reduced benthic and water-column production since Hurricane Katrina made landfall at the eastern border of Louisiana in August 2005 (Anton et al, 2006).

Summary and Conclusion

Dredging generates the greatest overall risk to submerged vegetation. These actions uproot, bury, and smother plants as well as decrease oxygen in the water and reduce the amount of necessary sunlight. Channel dredging to create and maintain waterfront real estate, marinas, and waterways will continue to cause the greatest impacts to higher salinity submerged vegetation. Hurricanes generate substantial overall risk to submerged vegetation by burial and eroding channels through seagrass beds. When combined with other stresses, impacted seagrass beds may fail to recover.

The oil and gas industry and land developers perform most new dredging in the cumulative activity area. Within the cumulative activity area, most dredging that impacts lower salinity submerged vegetation has occurred in Louisiana and Texas in support of inshore petroleum development. Cumulatively, offshore oil and gas activities are projected to generate another 6-8 pipeline landfalls in Texas and 25-36 pipeline landfalls in Louisiana. Mitigation may be required to reduce undesirable impacts of dredging to submerged vegetation. Maintenance dredging of navigation channels may sustain the impacts of original dredging. The most effective mitigation for direct impacts to submerged vegetation beds is avoidance, as well as the use of turbidity curtains to reduce turbid conditions.

Large water control structures associated with the Mississippi River influence salinities in coastal areas, which in turn influences the location of seagrass communities and associated epifauna. Where flooding or other freshwater flow to the sea is reduced, regional average salinities generally increase. Average salinities in areas of the coast that receive increased freshwater flows as a result of the above flood controls are generally reduced. Beds of submerged vegetation (seagrass) adjust their locations based on their salinity needs. If the appropriate salinity range for a species is located where other environmental circumstances are not favorable, the new beds will be either smaller, less dense, or may not colonize at all.

When the Mississippi River is in flood condition, floodways may be opened to alleviate the threat of levee damage. The floodways of the Mississippi River direct water to estuarine areas where flood waters may suddenly reduce salinities for a couple of weeks to several months. This lower salinity can damage or kill high-salinity seagrass beds if low salinities are sustained for longer periods than the seagrass species can tolerate. Opening one of the floodways of the Mississippi River is the single action that can adversely impact the largest areas of higher-salinity submerged vegetation.

Inshore oil spills generally present greater risks of adversely impacting submerged vegetation and seagrass communities than do offshore spills for the areas in a proposed action (Mississippi, Louisiana, and Texas). Given the large number of existing oil wells and pipelines in and near Chandeleur Sound and the designation by the OSRA analysis that Plaquemines Parish has one of the highest probabilities that a spill ≥1,000 bbl will make landfall, the risk of numerous contacts to seagrass beds in this vicinity may be high. Such contacts will result in die back to the seagrass vegetation and supported epifauna, which will be replaced for the most part within one to two growing seasons, depending upon the season in which the spill occurs. Although zero to little direct permanent mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude and refined oil has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987).

Because of the floating nature of oil and the microtidal range that occurs in this area, oil spills alone would typically have very little impact on seagrass beds and associated epifauna. Unusually low tidal events, increased wave energy, or the use of oil dispersants increase the risk of impact. Usually, epifauna residing within the seagrass beds is much more heavily impacted than the vegetation. The cleanup of slicks can cause significant scarring and trampling of submerged vegetation and seagrass beds while the slick is over shallow, protected waters that are less than 5-ft deep.

Seagrass communities and associated habitat can be scarred by anchor drags, trampling, trawling, loggerhead turtles, occasional seismic activity, and boats operating in water that is too shallow for their keels or propellers. These actions remove or crush plants. The greatest scarring results from smaller boats operating in the vicinities of larger populations of humans and registered boats. A few State and local governments have instituted management programs that have resulted in reduced scarring.

In general, a proposed action would cause a minor incremental contribution to impacts on submerged vegetation from dredging, boat scarring, pipeline installations and possibly oil spills. Dredging generates the greatest overall risk to submerged vegetation, and hurricanes cause direct damage to seagrass beds, which may fail to recover in the presence of cumulative stresses. A proposed action would have a minor contribution to dredging from maintenance of channels.

4.5.4. Impacts on Sensitive Offshore Benthic Resources

4.5.4.1. Continental Shelf Benthic Resources

4.5.4.1.1. Live-Bottoms (Pinnacle Trend)

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions plus those related to prior and future OCS lease sales, and to tanker and other shipping operations that may occur and adversely affect live bottoms (low-relief and pinnacle trend features). Specific OCS-related impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, blowouts, and operational discharges by tanker ships. Non-OCS-related impacts, including commercial fisheries, natural disturbances, additional anchoring by recreational boats, and other non-OCS commercial vessels, as well as spillage from import tankering, all have the potential to alter live bottoms.

It is assumed protective stipulations for live bottoms will be part of appropriate OCS leases and existing site/project-specific mitigations will be applied to OCS activities on these leases or supporting activities on these leases. Stipulations and mitigations require operators to do the following:

- locate potential individual live bottoms and associated communities that may be present in the area of proposed activities and,
- protect sensitive habitat potentially impacted by OCS activities by requiring appropriate mitigation measures.

Stipulations and mitigations do not protect the resources from activities outside of MMS jurisdiction (i.e., commercial fishing, tanker and shipping operations, or recreational activities).

Non-OCS activities have a greater potential to affect the hard-bottom communities of the region than MMS-regulated activities. Natural events such as extreme weather and fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms) may impact low-relief, live-bottom communities of the CPA. Because of the depth of the bottom in the Pinnacle Trend area, waves seldom have a direct influence. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments. These forces are not expected to be strong enough to cause direct physical damage to organisms living on the reefs. Rather, currents are created by the wave action that can resuspend sediments to produce added turbidity and sedimentation. The animals in this region are well-adapted to the effects common to this frequently turbid environment. There are no known pinnacle features located within the WPA.

Recreational boating, fishing, and import tankering may severely impact low-relief, live-bottom communities. Ships anchoring near major shipping fairways of the CPA, on occasion, may impact sensitive areas located near these fairways. Numerous fishermen also take advantage of the relatively shallow and easily accessible resources of the region and anchor at hard-bottom locations to fish.

Bottom longlining could potentially result in cumulative impacts to live-bottom (Pinnacle Trend) communities. If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. De Forges et al. (2000) report threats to deepwater biological communities by fishing activity off New Zealand.

This is particularly the case in the pinnacle trend area. Therefore, several instances of severe and permanent physical damage to the pinnacle features and the associated live bottoms could occur as the result of non-OCS activities. It is assumed those biota associated with live bottoms of the CPA are well adapted to many of the natural disturbances mentioned above. A severe human disturbance, however, could cause important damage to live-bottom biota, possibly leading to changes of physical integrity, species diversity, or biological productivity exceeding natural variability. If such an event were to occur, recovery to pre-impact conditions could take as much as 10 years.

As with anchoring, the placement of drilling rigs and production platforms on the seafloor crushes the organisms directly beneath the legs or mat used to support the structure. The areas affected by the placement of the rigs and platforms would predominantly be soft-bottom regions where the infaunal and epifaunal communities are ubiquitous. Because of local bottom currents, the presence of conventional bottom-founded platform structures can cause scouring of the surficial sediments (Caillouet et al., 1981).

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels disturb areas of the seafloor. These disturbances are considered the greatest OCS-related threat to live-bottom areas. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current. Anchor damage could include crushing and breaking of live/hard bottoms and associated communities. Anchoring often destroys a wide swath of habitat when a vessel drags or swings at anchor, causing it to drag the seafloor. The biological stipulations limit the proximity of new activities to live bottoms and sensitive features. Platforms are required to be placed away from live bottoms; thus, anchoring events near platforms are not expected to impact the resource. Misplacement of anchors could severely impact hard-bottom substrate, which has recovery rates (which are not well documented) estimated at 5-20 years depending on the severity.

Both explosive and nonexplosive structure-removal operations disturb the seafloor and can potentially affect nearby live/hard-bottom communities. Structure removal using explosives (the most common removal method) can suspend sediments, which settle much in the same manner as discussed below for muds and cuttings discharges. Individual charges used in OCS structure removals are required to be 23 kg (50 lb) or less, and are detonated 5 m (15 ft) below the mudline, which may attenuate shock waves in the seafloor within less than 100 m (328 ft) from the structure (Baxter et al., 1982). Sessile and other benthic organisms are known to resist the concussive force of structure-removal-type blasts. Sediment resuspension associated with structure removals would not last long and in some cases, does not occur at all (Gitschlag, personal communication, 2001). Resuspended sediments would impact an area within a radius of approximately 1,000 m (3,281 ft). Therefore, the explosive removal of structures is not expected to affect these sensitive areas. Should low-relief, hard-bottom communities incur any damages as a result of the explosive removal of structures, impacts would include restricted cases of mortality, and the predicted recovery to pre-impact conditions would be accomplished in less than 10 years.

Routine discharges of drilling muds and cuttings by oil and gas operations could affect biological communities and organisms through a variety of mechanisms, including the smothering of organisms through deposition or less obvious sublethal toxic effects (impacts to growth and reproduction). The protective lease stipulations and site-specific mitigations would prevent drilling activities and drilling discharges from occurring directly over pinnacle features or associated habitat. Drilling discharges should reach undetectable concentrations in the water column within 1,000 m (3,281 ft) of the discharge point, thus limiting potential toxic effects to benthic organisms. Any effects would be expected to diminish with increasing distance from the discharge area. Although Shinn et al. (1993) found detectable levels of metals from muds out to 1,500 m (4,921 ft) from a previously drilled well site in the pinnacle trend area, the levels of these contaminants in the water column and sediments are expected to be much lower than those required by new USEPA discharge regulations and permits (**Chapter 4.1.3.4**). Regional surface currents and the water depth (>40 m, >131 ft) would greatly dilute the effluent before it reaches benthic communities. Deposition of drilling muds and cuttings in live-bottom and pinnacle trend areas are not expected to greatly impact the biota of the pinnacles or the surrounding habitat. Furthermore, because the biota of the seafloor surrounding the pinnacles are adapted to life in turbid (nepheloid) conditions and high sedimentation rates in the western portions of the pinnacle trend area, deposition and turbidity caused by a nearby well should not adversely affect this sensitive environment. The impact from muds and cuttings discharged as a result of the cumulative scenario would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Recovery to pre-impact conditions from these sublethal impacts would take place within 10 years.

The depth of the low relief hard bottoms (>40 m), currents, and offset of discharges of produced waters and domestic and sanitary wastes (required by lease stipulations and postlease mitigations) would result in the dilution of produced waters and wastes to harmless levels before reaching any of the live bottom. Adverse impacts from discharges of produced waters and domestic and sanitary wastes as a result of the cumulative case would therefore be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

The Live Bottom (Pinnacle Trend) Stipulation, and site-specific mitigations are expected to prevent operators from placing pipelines directly upon live-bottom communities. The effect of pipeline-laying activities on the biota of these communities would be restricted to the resuspension of sediments, possibly causing obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Since burial of pipelines is not required in water depths >61 m (200 ft), very little of the pinnacle trend area (≥60 m (197 ft) depth) would be subjected to high turbidity caused by pipeline-laying activities. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

Assumptions of oil-spill occurrences, spill sizes, and estimates resulting from the OCS Program are described in **Chapter 4.3.1.1**. Oil spills have the potential to be driven into the water column. Measurable amounts have been documented down to a 10-m (33 ft) depth, although modeling exercises have indicated such oil may reach a depth of 20 m (66 ft). At this depth, however, the concentration of the spilled oil or dispersed oil would be at several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981). In the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities sank and proceeded to collide with the pinnacle features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time. For the purpose of this analysis, it is projected that no surface spills, regardless of size, would have an impact on the biota of live/hard bottoms, largely because the tops of the features crest at depths greater than 20 m (66 ft). Surface oil spills are therefore not expected to impact the hard-bottom communities.

Subsurface pipeline oil spills are not expected to cause damage to live/hard-bottom biota because the oil would initially adhere to the sediments surrounding the buried pipeline until the sediment reached its maximum capacity to retain the oil before the oil rapidly rises (typically 100 m/hr (328 ft/hr) in shallow water) (Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Oil-spill occurrence for the OCS Program is presented in **Chapter 4.1.3.4**. Since the lease stipulations and site-specific mitigations would prevent the installation of pipelines in the immediate vicinity of live/hard-bottom areas, there is little probability that a subsurface oil spill will impact live/hard bottoms. Should a pipeline spill occur in the immediate vicinity of a live/hard bottom, impacts, including the uptake of hydrocarbons and attenuated incident light penetration, could cause partial mortality of local biota. Most of the biota, however, would likely survive and recover once the live/hard bottoms were clear of oil. The adverse impacts from subsurface oil spills on live/hard bottoms would be minor in scope, primarily sublethal in nature, and the effects would be contained within a small area. Recovery to pre-impact conditions from these sublethal impacts could take place within 5-10 years.

Blowouts have the potential to resuspend sediments and release hydrocarbons into the water column, which may affect pinnacle-trend communities. Subsurface blowouts occurring near these communities can pose a threat to the biota. The severity and proximity of such an occurrence to live/hard bottoms cannot be predicted. The continued implementation of lease stipulations and mitigations should prevent blowouts from occurring directly on or in proximity to live/hard bottoms. What can be predicted is that such blowouts would cause sediments to be released and resuspended. A severe subsurface blowout within 400 m (1,312 ft) of a live/hard bottom could result in the smothering of the biota due to sedimentation. Since much of the live/hard-bottom biota is adapted to turbid conditions, most impacts would probably be sublethal with recovery taking place within 5 years. There are no pinnacles in the WPA; therefore, no impacts would be expected from blowouts associated with a proposed action in the WPA.

Should the Live Bottom (Pinnacle Trend) Stipulation not be implemented for the proposed actions or for future lease sales, OCS activities could have the potential to destroy part of the biological communities and damage one or several live/hard-bottom features. The most potentially damaging of these are the impacts associated with physical damages that may result from anchors, structure emplacement, and other bottom-disturbing operations. Potential impacts from oil spills larger than 1,000 bbl, blowouts, pipeline emplacement, mud and cutting discharges, and structure removals exist. The OCS Program, without the benefit of protective lease stipulations and site-specific mitigations, would probably have an adverse impact on live/hard bottoms of the EPA, particularly from anchor damage to pinnacle-trend features.

Summary and Conclusion

Non-OCS activities in the vicinity of the hard-bottom communities include recreational boating and fishing, import tankering, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms). These activities could cause severe damage that could threaten the survival of the live/hard-bottom communities. Ships using fairways in the vicinity of live/hard bottoms anchor in the general area of live/hard bottoms on occasion, and numerous fishermen take advantage of the relatively shallow and easily accessible resources of regional live/hard bottoms. These activities could lead to several instances of severe and permanent physical damage. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments. Because of the depth of the Pinnacle Trend area, these forces are not expected to be strong enough to cause direct physical damage to organisms living on the reefs.

Impact-producing factors resulting from routine activities of OCS oil and gas operations include physical damage, anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, discharges of produced waters, and discharges of domestic and sanitary wastes. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to live bottoms. Long-term OCS activities are not expected to adversely impact the live/hard-bottom environment if these impact-producing factors are restrained by the continued implementation of protective lease stipulations and site-specific mitigations. The inclusion of the Live Bottom (Pinnacle Trend) Stipulation would preclude the occurrence of physical damage, the most potentially damaging of these activities. The impacts to the live/hard bottoms are judged to be infrequent because of the small number of operations in the vicinity of live/hard bottoms. The impact to the live/hard-bottom resource as a whole is expected to be slight because of the projected lack of community-wide impacts. Because of the distance from the sensitive habitat, no effects are expected from activities located in the WPA.

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals should be minimized because of the proposed Live Bottom (Pinnacle Trend) Stipulation, and the dilution of discharges and resuspended sediments in the area. Potential impacts from discharges will probably be further reduced by USEPA discharge regulations and permits restrictions (**Chapter 4.1.3.4**). Potential impact from oil spills greater than 1,000 bbl would be restricted because of the depth of the features (>20 m (66 ft)) (if the spill occurs on the sea surface), because subsea pipeline spills are expected to rise rapidly, and because of the low prospect of pipelines being routed immediately adjacent to live/hard bottoms. The frequency of impacts to live/hard bottoms should be rare and the severity slight. Impacts from accidents involving anchor placement on live/hard bottoms could be severe in small areas (those actually crushed or subjected to abrasions).

The incremental contribution of a proposed action (as analyzed in **Chapter 4.2.2.1.4.1.1**) to the cumulative impact is expected to be slight, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts should be restricted by the implementation of the Live Bottom (Pinnacle Trend) Stipulation and site-specific stipulations, the depths of the features, and the currents in the live/hard-bottom area.

4.5.4.1.2. Topographic Features

The Topographic Features Stipulation is assumed to be in effect for this cumulative analysis. The continued application of this stipulation would prevent any direct adverse impacts on the biota of the topographic features potentially generated by oil and gas operations. The cumulative impact from routine oil and gas operations includes effects resulting from a proposed action (**Chapters 4.2.1.1.4.1 and 4.2.2.1.4.1.2**) as well as those resulting from past and future OCS leasing. These operations include anchoring, structure emplacement, muds and cuttings discharge, effluent discharge, blowouts, oil spills, and structure removal. Potential non-OCS-related factors include vessel anchoring, treasure hunting activities, import tankering, heavy storms and hurricanes, the collapse of the tops of the features due to dissolution of the underlying salt structure, commercial fishing, and recreational scuba diving.

Mechanical damage, including anchoring, is considered to be a catastrophic threat to the biota of topographic features. The proposed biological stipulation prohibits oil and gas leaseholders from anchoring vessels and placing structures within 152 m (500 ft) of the No Activity Zones; the stipulation does not affect other non-OCS activities such as anchoring, fishing, or recreational scuba diving. Detailed analysis of the extent to which non-OCS activities may take place is beyond the scope of this document; however, these activities are known to occur in proximity of the topographic features. Nearly all of the topographic features are found near established shipping fairways and are apparently well known fishing areas. The Flower Garden Banks National Marine Sanctuary along with the USCG enforces a conventional hook and line rule (one hook per line) for fishing within the boundaries of the Sanctuary, which includes Stetson Bank. Also, several of the shallower topographic features are frequently visited by scuba divers aboard recreational vessels. Anchoring at a topographic feature by a vessel involved in any of these activities could damage the biota. The degree of damage would depend on the size of the anchor and chain (Gittings and Bright, 1986). Anchor damages incurred by live bottom may necessitate more than 10 years to recover. The Flower Garden Banks National Marine Sanctuary has a maximum 100-ft vessel anchor designation, enforced by NOAA Enforcement as well as the USCG.

The use of explosives in treasure hunting operations is typically not a concern on topographic features with the exception of Bright Bank. The blasting of large areas of Bright Bank by treasure hunters has resulted in the loss of extensive live coral cover (Bright, 1985). Treasure hunters have damaged the bank as recently as 2001 (Hickerson and Schmahl, 2005). The recovery from such destructive activity may take in excess of 10 years, while partial resource loss is probably irreversible. Recovery of the system to pre-interference conditions would depend on the type and extent of damage incurred by individual structures (corals, etc.) of the topographic feature, however, recovery from the direct impacts from the use of explosives is unknown.

Impacts on the topographic features could occur as a result of spills or operational discharges from import tankering. Due to dilution and the depths of the crests of the topographic features, discharges should not reach topographic features in sufficient concentrations to cause impacts.

Impacts from natural occurrences such as hurricanes occasionally result in damage to the biota of the topographic features. When Hurricane Rita passed 95 km (60 mi) east of the East Flower Garden Bank, coral colonies were toppled, sponges and fields of finger coral (*Madracis mirabilis*) were broken, coral tissues were damaged by suspended sand and rocks, and large-scale shifts occurred in sand patches. Sixteen other banks were closer to the storm track and likely experienced severe effects. Hurricane Katrina may have caused similar damage on topographic features farther east. Another possible natural impact to the banks would be the dissolution of the underlying salt structure. This is unlikely and certainly beyond any human ability to regulate.

Depending on the levels of fishing pressure exerted, fishing activities that occur at the topographic features may impact local fish populations (**Chapters 4.2.1.1.8.1 and 4.2.2.1.10**). The collecting activities by scuba divers on shallow topographic features may have an adverse impact on the local biota. Collecting is prohibited at the Flower Garden Banks National Marine Sanctuary. Anchoring during recreational and fishing activities, however, would be the source of the majority of severe impacts incurred by the topographic features.

The continued application of the biological stipulation precludes anchoring on topographic features by oil- and gas-related operations. Detrimental impacts would result if oil and gas operators anchored pipeline barges, drilling rigs, and service vessels or if they placed structures on topographic features (Bright and Rezak, 1978; Rezak et al., 1985). The Topographic Features Stipulation restricts these activities within 152 m (500 ft) of the No Activity Zone, thus preventing adverse impacts on benthic communities of topographic communities. The routine discharge of drilling muds and cuttings is probably substantial under the cumulative scenario; it is assumed that several million barrels of drilling fluids and cuttings would be discharged in water depths less than 200 m (656 ft). The areal extent of the topographic features relative to the area of the entire CPA and WPA is small, so the actual amounts of these discharges in the vicinity of the topographic features would be a fraction of this total. Continued application of the Topographic Features Stipulation would require lease operators to comply with measures, such as shunting that would keep discharged materials at depths below sensitive biota. The USEPA, through its new NPDES discharge permit, also enacts further mitigating measures. As noted above under the proposed actions, drilling fluids can be moderately toxic to marine organisms (the more toxic effluents are not allowed to be discharged under new NPDES permits), and their effects are restricted to areas closest to the discharge point, thus preventing contact with the biota of topographic features. Small amounts of drilling effluent may reach a bank from wells outside the No Activity Zone; however, these amounts, where measurable, would be extremely small and would be restricted to small areas and have sublethal effects on the biota. Such impacts would occur infrequently and the severity of the impacts is assumed to be disruptive to only a few elements at the regional or local scale. Therefore, no interference with ecosystem performance would be incurred. Potential recovery of the system to pre-interference conditions would take place within 2 years.

With the inclusion of the proposed Topographic Features Stipulation, no discharges of effluents, including produced water would take place within the No Activity Zones. Discharges in areas around the No Activity Zone will be shunted to within 10 m (33 ft) of the seabed. This procedure, combined with the new USEPA discharge regulations and permits, should eliminate the threat of discharges reaching and affecting the biota of a topographic high. The impacts that these discharges could cause would be primarily sublethal damages that could lead to a possible disruption or impairment of a few elements at the regional or local scale, but no interference to the general ecosystem performance should occur. Potential recovery of the impacted area to pre-interference conditions would take place within 2 years.

Blowouts outside the No Activity Zones are unlikely to impact the biota of the topographic features. Predicted cumulative blowouts for the proposed actions for 40 years are in **Tables 4-2 and 4-3**. Few blowouts, if any, would occur in the immediate vicinity of the topographic features. It is assumed that a resuspension of sediments or a subsurface oil spill following a blowout could reach the biota of a topographic feature. If this were to occur, the impacts would be primarily sublethal with the disruption or impairment of a few elements at the local scale, but no interference to the general system performance would occur. Potential recovery of the impacted area to pre-interference conditions would take place within 2 years.

Oil-spill occurrence and contact probabilities for the OCS Program are presented in **Chapter 4.1.3.4**. However, because of the water depths in which topographic features are found, no oil from surface spills would reach the biota of concern at concentrations likely to cause impacts. However a subsurface oil spill could reach the biota of a topographic feature. It is assumed such spills would initially adhere to the sediments surrounding the buried pipeline or well site until the sediment reached its maximum capacity to retain the oil before rising (typically 100 m/hr (328 ft/hr); Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Any oil remaining at depth would be swept clear by currents moving around the topographic features (Rezak et al., 1983).

If a seafloor oil spill (e.g., pipeline) were to occur, the spill would have to come into contact with a biologically sensitive feature to have an impact. The extent of damage from a spill would probably be concentrated on one sensitive area (feature), due to the broad distribution of topographic features across the Western and Central Gulf. Given the random nature of spill locations, the potential impacts of oil spills on biological resources of a topographic feature would probably be restricted to discrete locations. The currents should steer any spilled oil around the features rather than directly upon them, lessening impact severity. Furthermore, No Activity Zones established by the proposed Topographic Features Stipulation would prohibit OCS activity within 152 m (500 ft) of such features thereby reducing the source of spills. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals and much of the other fully developed reef biota. It is anticipated that recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill could reach a coral covered area in lethal concentrations, the area so impacted would be small, but recovery of this area could take in excess of 10 years. Finally, in the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities or non-OCS related activities sank and collided with the topographic features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time. In November 1999, a +60 ft recreational vessel sank at the West Flower Garden Bank and remains unrecovered. Destructive impacts from the vessel colliding with the corals and associated biota of the West bank are unknown at this time.

Many platforms will be removed from the OCS Program each year in the vicinity of topographic features (**Tables 4-4, 4-5, and 4-6**). However, the proposed Topographic Features Stipulation would prevent the installation of platforms near the No Activity Zones, thus reducing the potential for impact from platform removal. The explosive removals of platforms should not impact the biota of the topographic features. Similarly, other activities that resuspend bottom sediments are unlikely to impact the topographic features.

Summary and Conclusion

Activities causing mechanical disturbance represent the greatest threat to the topographic features. This would, however, be prevented by the continued application of the Topographic Features Stipulation. Potential OCS-related impacts include anchoring of vessels and structure emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal.

The proposed Topographic Features Stipulation would preclude mechanical damage caused by oil and gas leaseholders from impacting the live-bottom communities of the topographic features and would protect them from operational discharges. As such, little impact would be incurred by the biota of the topographic features. New USEPA discharge regulations and permits would further reduce discharge-related impacts (**Chapters 4.2.1.1.2.2 and 4.2.2.1.2.2**). Recovery from any discharge-related impacts would take place within 2 years.

Blowouts could potentially cause damage to benthic biota, however, due to the application of the proposed Topographic Features Stipulation, blowouts would not occur in the immediate vicinity of the topographic features and associated biota; therefore, there would be little impact on the features. Potential recovery from any impact would take place within 2 years.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The proposed Topographic Features Stipulation would keep sources of OCS spills at least 152 m (500 ft) away from the immediate biota of the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals (in the case of the Flower Garden Banks and Stetson Bank) and much of the other fully developed biota. It is anticipated that potential recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill reached an area containing coral cover (e.g., Flower Garden Banks and Stetson Bank) in lethal concentrations, the impacted area would be small, but its recovery could take in excess of 10 years. Finally, in the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities or non-OCS related activities sank and proceeded to collide with the topographic features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time.

Non-OCS activities are thought to have the greatest potential of impacting the topographic features, particularly those that could mechanically disrupt the bottom (such as anchoring and treasure-hunting activities, as previously described). Natural events such as hurricanes or the collapse of the tops of the topographic features (through dissolution of the underlying salt structure) could cause severe impacts. The collapsing of topographic features is unlikely and would, at the most, impact a single feature. Impacts from scuba diving, fishing, ocean dumping, and discharges or spills from tankering of imported oil are likely to have little or no impact on the topographic features.

The incremental contribution of a proposed action (as analyzed in **Chapters 4.2.1.1.4.1 and 4.2.2.1.4.1.2**) to the cumulative impact is negligible because of the implementation of the Topographic Features Stipulation, which would limit mechanical impacts and operational discharges. Furthermore, there is a low probability and low risk of accidental OCS-related events such as blowouts and oil spills occurring in the immediate vicinity of a topographic feature.

4.5.4.2. Continental Slope and Deepwater Resources

Both chemosynthetic communities and nonchemosynthetic deepwater resources will be combined in this chapter. Cumulative factors considered to impact the deepwater benthic communities of the GOM include both oil- and gas-related and non-oil- and gas-related activities. The latter type of impacting factors includes activities such as fishing and trawling at a relatively small scale, and large-scale factors such as climate change. There are essentially only three fish (or "shellfish") species considered important to deepwater commercial bottom fisheries—the yellowedge grouper, tilefish, and royal red shrimp.

Yellowedge grouper habitat only extends to only about 275 m (902 ft). Bottom longlining for tilefish could potentially result in cumulative impact to deepwater communities as their habitat in the GOM extends to 540 m (1,772 ft) (FishBase, 2006b). If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. De Forges et al. (2000) report threats to deepwater biological communities by fishing activity off New Zealand. In the 1980's when the orange roughy fishery exploded off New Zealand, catches from aggregations around deep-sea seamounts sometimes retrieved 60 tons of fish from a 20-minute trawl. After just 10 years, the fishery collapsed to less than 20 percent of the preexploited abundance. Species similar to the targeted species in Australia and New Zealand (e.g., the orange roughy (genus *Hoplostethus*)), do occur in the GOM; however, they are not abundant and are smaller in size. There is no information that this species group of deep-sea fish has been exploited in the GOM. This is very fortunate because of the extensive destruction that would be caused to associated deepwater hard bottom associated with *Hoplostethus* preferred habitat. In the GOM, this is most always authigenic carbonate and likely also associated with chemosynthetic communities or potentially deepwater coral communities.

The royal red shrimp is fished for in some areas of the Gulf. Its depth range spans 180-730 m, but most are obtained from depths of 250-475 m (820-1,558 ft) in the northeastern part of the GOM (GMFMC, 2004a). This species would be obtained from trawling using traditional but modified shrimp trawls. The use of traps for royal red shrimp was prohibited in Amendment 11 of the Shrimp Fishery Management Plan (GMFMC, 2006a). If trawling occurred in sensitive areas of deepwater coral habitats, extensive damage to those communities could occur, but the areas where royal red shrimp are obtained are not known for hard-bottom communities, and the shrimp prefer soft bottom composed of sand, clay, or mud (CSA, 2002). Bottom fishing and trawling efforts in the deeper water of the CPA and WPA are currently minimal, and impacts to deepwater benthic communities are negligible.

Oil- and gas-related activities include pipeline and platform emplacement activities, anchoring, accidental seafloor blowouts, drilling discharges, and explosive structure removals. This analysis considers the effects of these cumulative factors related to the proposed actions and to future OCS sales.

Other regional sources of cumulative impact to deepwater benthic communities would be possible, but are considered unlikely to occur. Essentially no anchoring from non-OCS-related activities occurs at the water depths where these communities are found. Some impacts are highly unlikely yet not impossible, such as the sinking of a ship or barge resulting in collision or contaminant release directly on top of a sensitive, high-density chemosynthetic or significant nonchemosynthetic community such as coral communities.

One potentially significant large-scale source of impact could be potential effects of carbon sequestration in the deep sea as proposed by some international groups as a technique to reduce atmospheric carbon dioxide. Boyd et al. (2000) reported the successful iron fertilization of the polar Southern Ocean resulting in a large drawdown of carbon dioxide for at least 13 days and a massive plankton bloom for 30 days. A more recent evaluation of those Southern Ocean experiments have pointed out that there was limited evidence that there was any large quantities of carbon actually transported to the deep ocean (Buesseler and Boyd, 2003). Buesseler and Boyd go on to say that ocean iron fertilization may not be a cheap and attractive option if impacts on carbon export and sequestration are as low as observed to date. Recent papers also have highlighted the potential serious consequences of large scale CO_2 sequestration. Seibel and Walsh (2001) report extensive literature on the physiology of deep-sea biota indicating that they are highly susceptible to the CO_2 and pH excursions likely to accompany deep-sea CO_2 sequestration. The impacts of even very small excursions of pH and CO_2 could have serious, even global, deep-sea ecosystem impacts. Kita and Ohsumi (2004) suggest that sequestration of anthropogenic CO_2 could help reduce atmospheric CO_2, but they also summarized the potentially substantial biological impact on marine organisms.

On another side of this issue, a number of papers have identified a serious risk resulting from not reducing atmospheric CO_2 to shallow-water benthic organisms, particularly those with calcium carbonate shells and corals (Shirayama and Thornton, 2005; Kleypas et al., 1999; Barry et al., 2005). Corals, including deepwater species, rely on the saturation state of the carbonate mineral aragonite for calcification. Increases of CO_2 in marine waters have a direct impact on pH levels, which also decreases the aragonite saturation state with potentially severe impacts on coral growth. One issue raised in Barry et al. (2005) and Shirayama and Thornton (2005) is consideration of the trade-off between shallow-water interests and deep-sea habitats. Considering only the impacts to deep-ocean ecosystems for the decision to sequester large volumes of CO_2 deep-sea does not take into account the possible catastrophic damage of increasing global temperatures, including impacts to coral reefs and all benthic organisms with calcium carbonate shells. Total greenhouse gas emissions have increased by 16 percent to a CO_2 equivalent of 7.8 billion tons between 1990 and 2004 (USEPA, 2006d). Substantial additional research is needed before any large-scale actions would take place.

The greatest potential for cumulative adverse impacts to occur to the deepwater benthic communities, both chemosynthetic and nonchemosynthetic, would come from those OCS-related, bottom-disturbing activities associated with pipeline and platform emplacement (including templates and subsea completions), associated anchoring activities, discharges of muds and cuttings, and seafloor blowout accidents. The potential impacts to deepwater benthic communities from these activities are discussed in detail in **Chapter 4.2.1.1.4.2** for the WPA and **Chapter 4.2.2.1.4.2** for the CPA. The potential impacts from seafloor blowout accidents are discussed in **Chapter 4.4.4.2**.

As exploration and development continue on the Federal OCS, activities have moved into the deeper water areas of the GOM. Exploratory drilling technology now has the ability to drill in the deepest parts of the GOM. With this trend comes the certainty that increased development will occur on discoveries throughout the entire depth range of the WPA and CPA; these activities will be accompanied by limited unavoidable impacts to the soft-bottom deepwater benthos from bottom disturbances and disruption of the seafloor from associated activities. The extent of these disturbances will be determined by the intensity of development in these deepwater regions, the types of structures and mooring systems used, and the effective application of the avoidance criteria required under NTL 2000-G20. Activity levels related to the OCS Program for 2007-2046 in the WPA and CPA are shown in **Tables 4-5** and **4-6**, respectively. For the WPA deepwater offshore subareas W200-400, W400-800, W800-1600, W1600-2400, and W>2400, an estimated 650-909 exploration and delineation wells and 4,139-5,290 development wells are projected to be drilled, and 65-97 production structures are projected to be installed from 2007 to 2046. For these same water depths, 29-37 blowout accidents are projected. For the CPA deepwater offshore subareas C200-400, C400-800, C800-1600, C1600-2400, and C>2400, an estimated 1,445-2,003 exploration and delineation wells and 12,602-14,920 development wells are projected to be drilled, and 114-174 production structures are projected to be installed from 2007 to 2046. In the same water depths, 84-102 blowout accidents are projected.

Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths greater than 400 m (1,312 ft) (discussed in **Chapters 4.2.1.1.2.2, and 4.2.2.1.2.2**), but these discharges are distributed across wider areas and in thinner accumulations than they would be in shallower water depths. Potential local cumulative impacts could result from accumulations of muds and cuttings resulting from consistent hydrographic conditions and drilling of multiple wells from the same location causing concentrations of material in a single direction or "splay." It is not expected that detectable levels of muds and cuttings discharges from separate developments or from adjacent lease blocks would act as a cumulative impact to deepwater benthic communities due their physical separation and great water depths.

A major new deepwater effects study funded by MMS was completed in 2006—*Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the GOM* (CSA, 2006). This project included determinations of the extent of muds and cuttings accumulations resulting from both exploratory and development drilling at three sites in approximately 1,000 m (3,281 ft) of water. Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within the 500-m (1,640-ft) radius of what was termed near-field stations. Generally, areas mapped as drilling muds were identified within about 100 m (328 ft) of wellsites. Areas mapped as cuttings typically extended several hundred meters from wellsites.

The majority of deepwater chemosynthetic communities are of low density and are widespread throughout the deepwater areas of the Gulf. Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The frequency of such impact is expected to be low. Physical disturbance to a small area would not result in a major impact to the ecosystem. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are widely distributed but few in number and limited in size. They have a high standing biomass and productivity. High-density chemosynthetic communities would be largely protected by NTL 2000-G20, which serves to prevent impacts by requiring avoidance of potential chemosynthetic communities identified by association with geophysical characteristics or by requiring photodocumentation to establish the presence or absence of chemosynthetic communities prior to approval of the structure or anchor placements. Numerous new communities were recently discovered and explored using the submersible *Alvin* in 2006 as part of a new MMS study (USDOI, MMS, 2006n). These new communities were targeted using the same procedures integral to the biological review process and the use of NTL 2000-G20 targeting areas of potential community areas to be avoided by impacting oil and gas activities. Current implementation of these avoidance criteria and understanding of potential impacts indicate that high-density communities should be protected from burial by pre-riser discharges of muds and cuttings at the bottom and burial by muds and cuttings discharges from the surface.

Small impacts are expected to occur infrequently, but the impacts from bottom-disturbing activities, if they occur, could be quite severe to the immediate area affected. If it occurred, the disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. Similar recovery periods would be required if severe impacts occurred to well-developed, deepwater coral habitats (e.g., *Lophelia*). The severity of such an impact is such that there may be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

In cases where high-density communities are subjected to greatly dispersed discharges or resuspended sediments, the impacts are most likely to be sublethal in nature and limited in areal extent. The impacts to ecological function of high-density communities would be minor with recovery occurring within 2 years; however, minor impacts to ecological relationships with the surrounding benthos would also be likely.

Because of the great water depths, treated sanitary wastes and produced waters are not expected to have adverse cumulative impacts to any deepwater benthic communities. These effluents would undergo a great deal of dilution and dispersion before reaching the bottom, if ever.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events. The distance of separation provided by the adherence of NTL 2000-G20 would protect both chemosynthetic and non-chemosynthetic communities from the direct effects of deep-water blowouts. Subsea structure removals are not expected in water depths >800 m (2,625 ft), in accordance with 30 CFR 250, which includes all of the proposed lease sale area.

Oil and chemical spills (potentially from non-OCS related activities) are not considered to be a potential source of measurable impacts on any deepwater communities because of the water depth. Oil spills from the surface would tend not to sink. Oil discharges at depth or on the bottom would tend to rise in the water column and similarly not impact the benthos. In the case of chemosynthetic communities, there is also reason to expect that animals are resistant to at least low concentrations of dissolved hydrocarbons in the water, as communities are typically found growing in oil saturated sediments and in the immediate vicinity of active oil and gas seeps.

Deepwater coral and other hard-bottom communities not associated with chemosynthetic communities are also expected to be protected by general adherence to NTL 2000-G20 and the shallow hazards NTL 98-12 due to the avoidance of areas represented as hard bottom on surface anomaly maps derived from 3-D seismic records. Biological reviews are performed on all deepwater plans (exploration and production) and pipeline applications; these reviews include an analysis of maps and avoidance of hard-bottom areas, which are also one of several important indicators for the potential presence of chemosynthetic communities.

Summary and Conclusion

Impacts to deepwater communities in the GOM from sources other than OCS activities are considered negligible. The most serious impact-producing factor threatening chemosynthetic communities is physical disturbance of the seafloor, which could destroy the organisms of these communities. Such disturbance would most likely come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to chemosynthetic communities, but substantial accumulations could result in more serious impacts. Seafloor disturbance is considered to be a threat only to the high-density (Bush Hill-type) communities; the widely distributed low-density communities would not be at risk. The provisions of NTL 2000-G20 require surveys and avoidance prior to drilling or pipeline installation and will greatly reduce the risk. New studies are currently refining the information and confirming the effectiveness of these provisions throughout all depth ranges of the GOM (USDOI, MMS, 2006n). Confidence is increasing regarding the use of geophysical signatures for the prediction of the likely presence of chemosynthetic communities with the dramatic success of this project.

Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths in these areas and the low density of potentially commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes. Regionwide and even global impacts from $C0_2$ build-up and proposed methods to sequester carbon in the deep-sea (e.g., ocean fertilization) are not expected to have major impacts to deepwater habitats in the near future. More distant scenarios could include severe impacts.

The activities considered under the cumulative scenario are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years. If physical disturbance (such as anchor damage) or extensive burial by muds and cuttings were to occur to high-density, Bush Hill-type communities, impacts could be severe, with recovery time as long as 200 years for mature tube-worm communities. There is evidence that substantial impacts on these communities would permanently prevent reestablishment. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

The cumulative impacts on nonchemosynthetic benthic communities are expected to cause little damage to the ecological function or biological productivity of the expected typical communities existing on sand/silt/clay bottoms of the deep GOM. Large motile animals would tend to move, and recolonization from populations from neighboring substrates would be expected in any areas impacted by burial. Similar to chemosynthetic communities, the cumulative impacts on deepwater coral or other high-density, hard-bottom communities are expected to cause little damage to ecological function or biological productivity.

The incremental contribution of the proposed actions to the cumulative impact is expected to be slight, and to result from the effects of the possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension. Adverse impacts will be limited but not completely eliminated by adherence to NTL 2000-G20.

4.5.5. Impacts on Marine Mammals

The cumulative analysis considers past, ongoing, and foreseeable future human and natural activities that may occur and adversely affect marine mammals in the same general area that may be affected by a proposed action. These activities include effects of the OCS Program (proposed actions, and prior and future OCS sales), State oil and gas activity, commercial shipping, commercial fishing, recreational fishing and boating activity, military operations, scientific research, and natural phenomena. Specific types of impact-producing factors considered in this cumulative analysis include noise from numerous sources, pollution, habitat degradation, vessel strikes, and ingestion and entanglement in marine debris.

The major impact-producing factors relative to the WPA and CPA proposed actions are described in **Chapters 4.2.1.1.5 and 4.2.2.1.5**, respectively. Sections providing supportive material for the marine mammals analysis include **Chapters 3.2.3** (description of marine mammals), **4.1.1.2** (exploration), **4.1.1.3** (development and production), **4.1.1.7** and **4.1.2.1.11** (offshore and coastal noise), **4.1.2.1** (coastal infrastructure), and **4.3.1** and **4.4.5** (spills). The MMS completed an EA on geological and geophysical (G&G) activities (USDOI, MMS, 2004) and is currently in consultation with NOAA Fisheries Service for MMPA rulemaking and the associated ESA consultation. The G&G EA is hereby incorporated by reference.

Noise in the ocean has become a worldwide topic of concern, particularly in the last decade. The GOM is a very noisy place, and noise in the Gulf comes from a broad range of sources. Virtually all of the marine mammal species in the Gulf have been exposed to OCS-industrial noise due to the rapid advance into GOM deep oceanic waters by the oil and gas industry in recent years; whereas, 20 years ago, the confinement of industry to shallower coastal and continental shelf waters generally only exposed two species of marine mammals (the bottlenose dolphin and the Atlantic spotted dolphin) to industry activities and the related sounds. Most marine mammal species in the Gulf, and particularly the deepwater mammals, rely on echolocation for basic and vital life processes including feeding, navigation, and conspecific and mate communication. Noise levels that interfere with these basic mammal capabilities could have very serious impacts on individuals and populations. The OCS-industry operations contribute noise to the marine environment from several different operations. As noted in **Chapter 4.1.1.7**, it is believed that most of the industry-related noise is at lower frequencies than is detectable or in the sensitivity range of most of the GOM marine mammal species. However, most of the information on marine mammal hearing is inferred, and there are reports of species reacting to sounds that were not expected to be audible.

Industry noise sources include seismic operations, fixed platforms and drilling rigs, drilling ships, low-flying aircraft, vessel traffic, and explosive operations, particularly for structure removal. **Chapter 4.1.1.7** and **Table 4-4** discuss and show the expected sources of many of these impacts for the OCS Program, as well as the expected sources from past, present, and future OCS-industry operations. Many other sources also contribute to the overall noise in the GOM. Vessel propulsion noise is the greatest source of noise in the world ocean and is reported to contribute 90 percent of the manmade noise worldwide (Woods Hole Oceanographic Institution, 2003). Noise increases with ship size, and supertankers can produce up to 200 dB of steady, uninterrupted sound. The GOM is a very active shipping area and supertankers are very common. Other groups such as the military (U.S. Navy (USN) and USCG) and other Federal agencies (USEPA, COE, and NOAA Fisheries Service), dredges, commercial fishermen, and recreational boaters, operate vessels and contribute to the ambient noise in the Gulf. Industry service boats are numerous and are expected to make 52,175-68,050 and 115,675-147,175 round trips in the WPA and CPA, respectively, per year. Service vessels are a large contribution to ship noise; however, service boats are not nearly as large or as loud as commercial shipping vessels. Also, service vessels travel rapidly and, thus, an area is ensonified for only a brief time. Marine mammal avoidance guidelines listed in the Vessel Strike NTL should minimize the chance of marine mammals being subject to the increased noise level of a service vessel in very close proximity. Aircraft overflights are another source of noise and can cause startle reactions in marine mammals, including rapid diving, change in travel direction, and dispersal of marine mammal groups. With 950,000-1,500,000 helicopter take offs/landings expected per year from activity related to past, proposed, and future lease sales, OCS-industry activity contributes greatly to this noise source. Although air traffic well offshore is limited, the military maintains nine military warning areas and five water test areas in the Gulf. Some commercial fisheries include aerial surveillance. Scientific research aerial surveys are occasionally scheduled over the GOM. Commercial and private aircraft also traverse the area. Flight level minimum guidelines from NOAA and corporate helicopter policy should help mitigate the industry-related flight noise, though lower altitudes near shore and as the helicopter lands and departs from rigs could impact marine mammals in close proximity to the structures or shore bases. Occasional overflights are not expected to have long-term impacts on marine mammals.

The OCS-industry drilling impacts were discussed in **Chapter 4.1.1**. State oil and gas activities (**Chapter 4.1.3.1)** also create drilling and associated noise, particularly in Texas and Louisiana State waters. Although much of the focus is on industry operations in deep water, there is still interest and activity in more shallow and even coastal waters for oil and gas production. Similarly, explosive structure removals put considerable sound into the ocean, and these can occur in Federal or State waters. The COE also engages in some explosive and pile-driving operations that create loud but temporary noise. Such COE activities are consulted on with NOAA Fisheries Service, and mitigations are included, often similar to the mitigations employed by MMS in consultation with NOAA Fisheries Service. Mitigations for explosive removals are stated in the applicable MMS NTL, and these will be fortified by programmatic rulemaking under the MMPA that is now in the final stages between NOAA Fisheries Service and MMS. Observations to minimize the possibility of a marine mammal being near an explosive removal mitigate these loud but very brief noises.

Seismic exploration is the source of the loudest, and perhaps most controversial, OCS-industry activity. Details on seismic impacts on marine mammals are given in **Chapter 4.1.1.2.1,** and complete information is included in the G&G EA (USDOI, MMS, 2004). Seismic exploration is an integral part of oil and gas discovery, development, and production in the GOM. With technical advances that now allow extraction of petroleum from the ultra-deep areas of the Gulf, seismic surveys are routinely conducted in virtually all water depths of the western GOM, including the deep habitat of the endangered sperm whale. Noise and acoustic disturbance have been topics of great debate in the last several years, and there is general agreement that the use of sonar, particularly by the military, has in some cases been associated with very severe impacts to certain species of marine mammals in recent years. Seismic airgun sounds are often incorrectly lumped with sonar noise as sources of marine mammal disturbance. Though there are anecdotal associations between mammal disturbance and airgun noise, most of those have other factors occurring at the same time (i.e., sonar use) that may be responsible for any adverse impacts. However, seismic surveys have the potential to impact marine mammals. The MMS has petitioned NOAA Fisheries Service for rulemaking under the MMPA for seismic operations, and NOAA Fisheries Service is currently developing an EIS. In the interim, and in response to terms and conditions in the NOAA Fisheries Service Biological Opinion for Lease Sale 184 in 2002, MMS developed mitigations for the seismic industry that require, among other things, dedicated marine mammal observers aboard all seismic vessels, gradual ramp-up of the airgun array, and shutdowns of airgun firing if a whale gets within 500 m (1,640 ft) of an active airgun array. Although shutdowns are not extremely frequent, they do occur. Also, as reported in **Chapter 3.2.3**, current research by MMS and partners did not detect avoidance of seismic vessels or airguns by sperm whales. Although that finding (or lack of finding) could be interpreted several ways, it is likely that the whales, which appear to generally remain in the northern Gulf year round, are habituated to seismic operations. Since the sperm whale is the only endangered cetacean (whale or dolphin) in the GOM, most of the research has focused on that species. However, other species may react very differently to seismic disturbances. Ongoing research will be required to detect any changes in species abundance or distribution, and even with research, such changes would likely be very difficult to establish on a small scale. For the sperm whale, the most recent abundance was estimated to be 1,349 individuals, based on surveys conducted from 1996 to 2001 (Waring et al., 2004). The previous abundance estimate based on surveys from 1991 to 1994 was 530 individual sperm whales. Obviously it is extremely unlikely that the actual numbers of sperm whales increased by this amount, and there are numerous reasons that the two estimates are dissimilar. However, it does tend to discount the possibility that anthropogenic disturbance in the northern GOM is displacing sperm whales. Research has shown that sperm whales are distributed throughout the deeper waters of the northern GOM, not mainly in the Mississippi Canyon as previously thought. With seismic surveys frequently conducted in the WPA and CPA, it is likely that naive sperm whales (those that have not been exposed to seismic sound) are few or none in the northern Gulf. The GOM sperm whales have generally been smaller than sperm whales in other areas, and genetic research is indicating a unique stock and a population that is almost exclusively females and immature males. One of the many yet-to-be-unraveled mysteries of the GOM sperm whale is where the adult males are found. Very few (<10) whales that were suspected of being mature bulls have been observed in the Gulf. Yet, there are many calves, including newborns, seen regularly. This may also be an indication of a thriving population that has apparently adapted to a very industrial GOM. Stress, particularly at the individual animal level, would be impossible to observe, however. Over the long term, stress to a population could cause very significant adverse effects, including disease, reproductive failure, and population decline. Tools such as the "S-Tag" that allow the tracking of individual whales, and sometimes several individuals in a group, over the span of weeks and months, are a huge help for detecting some behavioral changes, as well as learning what "typical" whale behavior is. This tag also allows researchers to pinpoint the later location of an animal for a follow-up visual contact to check the physical appearance of the whale months after tagging.

Pollution of marine waters is another potentially adverse impact to marine mammals in the GOM. Information on drilling fluids and drill cuttings and produced waters that would be discharged offshore is discussed in **Chapter 4.1.1.4.1**. Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Marine mammals may periodically be exposed to these discharges. Direct effects to marine mammals are expected to be sublethal. Indirect effects via food sources are not expected because of dilution and dispersion of offshore operational discharges. Another OCS-industry form of pollution is oil spills. Impacts of these accidental events to marine mammals have been discussed in **Chapter 4.4.5**. Advances in oil-spill prevention technologies have greatly reduced the amount of oil that enters the marine environment accidentally. However, there is still the potential for an oil spill. Many small spills are estimated as a result of the OCS Program. The probability of a spill will decrease as the projected size of the spill increases. Marine mammals are likely to contact oil in the marine environment over their life span. However, because of dilution and weathering, such contact is expected to be sublethal. Indirect effects from the exposure of prey species to oil are also expected to be sublethal. Oil in the ocean can and does come from sources other than industry operations. Ships are known to illegally pump oily bilges into the environment. Mechanical failure on any type of vessel can lead to an oil spill, though usually small. Even natural seeps on the floor of the GOM can result in an oil slick or sheen on the surface (NRC, 2003).

Pollution in the ocean comes from many point and nonpoint sources and the GOM is certainly no exception. The drainage of the Mississippi River results in massive amounts of chemicals and other pollutants being constantly poured into the Gulf. The zone of hypoxia on the Louisiana-Texas shelf is one of the largest areas of low oxygen in the world's coastal waters (Murray, 1997) (see **Chapter 3.1.2.2**, Marine Waters). Since most of the marine mammals in the Gulf are oceanic deepwater dwellers, the impact of coastal and run-off pollution is greatly minimized as a result of dilution and dispersal. Primarily, the bottlenose dolphin and the manatee are most at risk for nearshore pollution. Bottlenose dolphins have been reported having very high levels of contaminants, including heavy metals, in tissue samples. Coastal dolphins generally have higher contaminant levels than offshore dolphins, which supports the dilution and dispersal theory. Prey species also affect the influence of pollution on marine mammals. Biomagnification in fish results in the generally higher contaminant levels of fish-eating marine mammals over squid-eating species. Manatees are herbivores, but pollution and habitat degradation are major obstacles for the manatee. Manatees are exposed to pesticides by ingesting aquatic vegetation containing concentrations of these compounds. The propensity of manatees to aggregate at industrial and municipal outfalls also may expose them to high concentrations of contaminants. Antifouling bottom paint on the hulls of boats has been linked to the release of contaminants. For coastal dolphins and especially manatees that are very well known to frequent marinas and scratch on the hulls of vessels, areas with high concentrations of vessels may have extremely polluted waters.

Given the many sources of unchecked pollution in the Gulf, the amount of additional contaminant contributed by the oil and gas industry is negligible. Strict controls on discharges from structures and vessels, and cutting edge technology to minimize the possibility of an oil spill, and the extent of one should it occur, greatly reduce industry's contribution to ocean pollution.

Marine debris has an impact in the ocean. Plastics in particular, and from many different sources, pose a threat to the environment and a serious threat to marine mammals. Ingestion of plastic can cause a digestive gut blockage and ultimately death for a marine mammal. Entanglement in anything from 6-pack rings to strapping bands to discarded monofilament nets can result in injury and very slow death for marine mammals. A wide variety of debris is commonly observed in the Gulf and it comes from both terrestrial and marine sources. The offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore in 1995 (Miller et al., 1995). Since that time, industry has implemented waste management programs and greatly improved waste handling. More efficient gear packaging and better galley practices have significantly reduced the amount of waste generated offshore. Annual marine debris awareness training, as per the MMS NTL, targets the accidental loss of material from vessels and structures. With these practices in place and compliance with applicable regulations and guidelines, the amount of marine debris contributed by a proposed action would be minimal.

Vessel strikes are a serious threat to marine mammals in the GOM. A collision between a marine mammal and a ship will result in injury and likely death. The increase in vessel traffic due to the proposed action would increase the probability of a vessel strike and the injury or death of some animals. The increased vessel traffic may alter behavior of marine mammals by avoidance, displacement, or attraction to the vessel. However, those effects are expected to be short-term. Industry-related vessels are only a part of the shipping activity in the Gulf. All manner of commercial shipping vessels, commercial fishing vessels, military ships, research ships, recreational craft, and others are always present in the Gulf. The MMS Vessel Strike NTL provides guidelines to avoid a vessel/mammal collision and to minimize harassment of mammals by vessels approaching too closely. It also provides for the reporting of injured or dead protected species. Industry vessel operators are aware of the danger that a collision would pose to the human crew and equipment. It would be in their best interest, and that of the marine mammal, to give wide berth. Although OCS vessel traffic would be a major component of the cumulative vessel impacts, professional piloting and regulatory guidelines would minimize the impact of the OCS segment of vessel traffic. Some factions of the boating public, mainly recreational fishermen and boaters, create adverse impacts by paying too much attention rather than not enough. Although most of these interactions are because of ignorance rather than malicious intent, reports of harassment, inappropriate feeding, and even attempting to swim with marine mammals are common. Dolphins have been injured and killed after becoming accustomed to being fed by humans. Animals become sick from eating the "food" that people throw. Very close approaches by boats are likely major causes of stress in marine mammals, as is chasing and following. The presence of industry structure in the deep waters of the Gulf may indirectly be encouraging these interactions. Recreational fishing vessels run much farther out to get to the improved fishing at a structure. This also puts these vessels in oceanic marine mammal waters. Service-vessel crews that keep attention on the water and that intentionally avoid marine mammals should not pose a threat to marine mammal populations

Other activities may have adverse effects on marine mammals. Occasionally, numbers of marine mammals strand, either alive or already dead. Die-offs happen infrequently but can seriously deplete small, discreet stocks. The causes of die offs are not always well known and vary by event. Some appear to be triggered by natural events (i.e., unusually cold weather) but others are suspected to at least be indirectly caused by pollution of various contaminates. Exposure to certain compounds may weaken the natural immunity of marine mammals and make them susceptible to viruses and disease that would normally not affect them. Certain viruses are being observed more frequently than in the past.

The Gulf has very little fishery interaction with marine mammals, compared with other areas. However, marine mammals can be injured or killed by commercial fishing gear. Mammals can either get hung on longline hooks or can be scooped into a net by a shrimp boat or groundfish vessel. There is also the chance of entanglement by lines from crab traps to buoys. Gillnets, which have now been banned in many places around the Gulf, have been reported to take marine mammals. Reports of these impacts are uncommon.

Scientific research can impact marine mammal species. The MMS has conducted numerous marine mammal research cruises, and permitted activities have included tagging and biopsy sampling. Protocols are always in place to keep the mammals safe, but some of the research techniques do involve harassment and possible stress to the animal. Scientific seismic studies could have the same impact with the same very loud noise as industry seismic work. Scientific groundfish or shrimp cruises can entrap a dolphin in a net just as commercial fisheries can. Scientific aerial surveys are also periodically conducted in the Gulf, and aircraft can startle mammals. Circling pods for identification may stress multiple individuals in a pod. Such marking techniques as freeze branding were used in the past to do mark-recapture studies. This required the live capture and branding of dolphins. Both the Navy and the public-display industry took bottlenose dolphins from the Gulf in years past. A moratorium on live captures has been in effect for several years, as captive breeding programs have become successful enough to provide dolphins for aquariums and zoos.

Lastly, tropical storms and hurricanes are normal occurrences in the Gulf and along the coast. Generally, the impacts have been localized and infrequent. However, in the last two years the GOM has been extremely hard hit by very powerful hurricanes. Few areas of the coast have not suffered some damage in 2004 and 2005, and activities in the Gulf have also been severely impacted. In 2004, Hurricane Ivan took a large toll on oil and gas structures and operations in the Gulf and caused widespread damage to the Alabama-Florida Panhandle coast. In 2005, Hurricanes Katrina, Rita, and Wilma reached Category 5 strength in the GOM. These storms caused damage to all five of the Gulf Coast States and damage to structures and operations both offshore and onshore. The actual impacts of these storms on the animals in the Gulf, and the listed species and critical habitat in particular, have not yet been determined and, for the most part, may remain very difficult to quantify. Examples of other impacts that may have affected species include oil, gas, and chemical spills from damaged and destroyed structures and vessels (although no major oil spills were reported, several lesser spills are known to have occurred), increased trash and debris in both offshore and inshore habitats, and increased runoff and silting from wind and rain. Not only are the impacts themselves difficult to assess, but the seasonal occurrence of impacts from hurricanes is also impossible to predict. Generally, the far offshore species and the far offshore habitat are not expected to have been severely affected in the long term. However, species that occupy more nearshore or inshore habitats may have suffered more long-term impacts.

Summary and Conclusion

Activities considered under the cumulative scenario could affect protected cetaceans and sirenians. These marine mammals could be impacted by the degradation of water quality resulting from operational discharges, vessel traffic, noise generated by platforms, drillships, helicopters and vessels, seismic surveys, explosive structure removals, oil spills, oil-spill-response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact on marine mammals is expected to result in a number of chronic and sporadic sublethal effects (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. Few deaths are expected from oil spills, chance collisions with OCS service vessels, ingestion of plastic material, commercial fishing, and pathogens. Oil spills of any size are estimated to be recurring events that would periodically contact marine mammals. Deaths as a result of structure removals are not expected to occur due to mitigation measures (e.g., NOAA Fisheries Observer Program). Disturbance (noise from vessel traffic and drilling operations, etc.) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected, the ecological importance of the disturbed area, the environmental and biological parameters that influence an animal’s sensitivity to disturbance and stress, or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships, although expected to be rare events, could cause serious injury or mortality. Natural phenomenon, such as tropical storms and hurricanes, are impossible to predict, but they will occur in the GOM. Generally, the offshore species and the offshore habitat are not expected to have been severely affected in the long term. However, species that occupy more nearshore habitats may have suffered more long-term impacts.

Effects of the incremental contribution of a proposed action combined with non-OCS activities may be deleterious to cetaceans occurring in the GOM. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and size of animals affected.

4.5.6. Impacts on Sea Turtles

This cumulative analysis considers the effects of impact-producing factors related to a proposed action along with impacts of other commercial, military, recreational, offshore, and coastal activities that may occur and adversely affect populations of sea turtles in the same general area of the proposed actions in the WPA and CPA. The combination of potential impacts resulting from a proposed action in addition to prior and future OCS sales, dredging operations, military operations, water quality degradation, natural catastrophes, pollution, recreational and commercial fishing, vessel traffic, beach nourishment, beach lighting, power plant entrainment, and human consumption affect the loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles found in the GOM. Major impact-producing factors related to the WPA and CPA proposed actions that may occur are reviewed in detail in **Chapters 4.2.1.1.6 and 4.2.2.1.6,** respectively. Sections providing supportive material for the sea turtle analysis include **Chapters 3.1** (physical environment), **3.2.4** (description of sea turtles), **4.1.1** (offshore impact-producing factors), **4.1.2** (coastal impact-producing factors), **4.1.3** (other activities), and **4.4** (environmental impacts of accidental events).

The Gulf Coast is a well-populated and growing area, and development of previously unusable land for residential and commercial purposes is common. Although some areas of the Gulf Coast have begun to cater to ecotourism by better management of resources, other areas continue to increase attractions particularly for tourists, such as jet skis and thrill craft, which may pose a threat to listed species or their habitats. Increased populations often result in increased runoff and dumping. Many areas around the Gulf already suffer from very high contaminant counts due to river and coastal runoff and discharges. Contaminants may accumulate in species or in prey species.

Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and, due to the USEPA permit regulations on discharges, are considered to have little effect (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would more likely be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling mud discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web. This could ultimately reduce reproductive fitness or longevity in sea turtles.

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect sea turtle foraging habitat through destruction of seagrass beds and live-bottom communities used by sea turtles (Gibson and Smith, 1999). At the same time, it should be noted that structure installation creates habitat for subadult and adult sea turtles, which may enhance the recovery of some turtle populations.

Noise from service-vessel and helicopter traffic may cause a startle reaction from sea turtles and produce temporary stress (NRC, 1990). Helicopter traffic would occur on a regular basis. It is projected that 285,000-450,000 OCS-related helicopter operations (take-offs and landings) would occur annually in the support of OCS activities in the WPA (**Table 4-5**). Similarly, estimates of annual OCS-related helicopter operations in the CPA are 665,000-1,050,000 take-offs and landings (**Table 4-6**). The FAA's Advisory Circular 91-36C encourages pilots to maintain greater than minimum altitudes near noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. The air space over the GOM is used extensively by the DOD for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf (**Figure 2-2**). Additional activities, including vessel operations and ordnance detonation, also affect sea turtles. The USN Mine Warfare Center in Corpus Christi, Texas, may take annually up to five loggerheads and two leatherbacks, hawksbills, greens, or Kemp's ridleys, in combination, during training activities in the western GOM. The U.S. Air Force operations in the Eglin Gulf Test Range in the eastern GOM may also kill or injure sea turtles. Air-to-surface gunnery testing is estimated to kill a maximum of three loggerheads, two leatherbacks, and one green, hawksbill or Kemp's ridley. Search and rescue training operations are expected to have a low level of impacts, taking two turtles over a 20-year period. Private and commercial air traffic also traverse these areas and have the potential to cause impacts to sea turtles.

Other sound sources potentially impacting sea turtles include seismic surveys and drilling noise. The potential impacts of anthropogenic sounds on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on prey species. Noise-induced stress has not been studied in sea turtles. Seismic surveys use airguns to generate sound pulses which are a more intense sound than other nonexplosive sound sources. Seismic activities are expected to be primarily annoyance to sea turtles and cause a short-term behavioral response. However, sea turtles are included in the mitigations required of all seismic vessels operating in the GOM as stated in NTL 2004-G01, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program." The MMS has petitioned NOAA Fisheries Service for programmatic rulemaking for seismic activities under the MMPA. The MMS has also requested consultation under the ESA with NOAA Fisheries Service for seismic activities. The NOAA Fisheries Service has awarded a contract for an EIS. It is expected that drilling noise will periodically disturb and affect turtles in the GOM. Based on the conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions (such as those produced by operating platforms) could cause increased surfacing and deterrence behavior from the area near the sound source.

Increased surfacing places turtles at greater risk of vessel collision. Vessel traffic, particularly supply boats running from shore bases to offshore structures, is one of the industry activities included in this proposed action. Collisions between service vessels or barges and sea turtles would likely cause fatal injuries. It is projected that 52,175-68,050 OCS-related, service-vessel round trips would occur annually in support of OCS activities in the WPA (**Table 4-5**). The estimated number of OCS-related, service-vessel trips occurring annually in the CPA is calculated at 115,675-147,175 trips (**Table 4-6**). It is important to note that these numbers take into account all the activities projected to occur from past, proposed, and future lease sales. In response to terms and conditions of previous NOAA Fisheries Service Biological Opinions, and in an effort to minimize the potential for industry-related vessel strikes to marine mammals and sea turtles, MMS issued NTL 2003-G10, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting." Vessel-related injuries were noted in 13 percent of stranded turtles examined from the Gulf and the Atlantic during 1993 (Teas, 1994). Increased vessel traffic in the Gulf increases the probability of sea turtle ship strikes. Regions of greatest concern may be those with high concentrations of recreational boat traffic, such as the many coastal bays in the Gulf. Potential adverse effects from Federal vessel operations in the action area of this proposed action include operations of the USN and USCG, which maintain the largest Federal vessel fleets; USEPA; NOAA; and COE. The NOAA Fisheries Service has conducted formal consultations with USCG, USN, NOAA, and other Federal agencies, including MMS, on the activities of their vessels or the vessels considered part of any permitted activity. The NOAA Fisheries Service has recommended conservation measures for operations of agency, contract or private vessels to minimize impacts on listed species. However, these actions represent the potential for some level of interaction and, in some cases, conservation measures only apply to areas outside the proposed action area. Thus, operations of vessels by Federal agencies within the action area (i.e., USN, NOAA, USEPA, and COE) may adversely affect sea turtles. However, the in-water activities of some of those agencies are limited in scope, as they operate a limited number of vessels or are engaged in research/operational activities that are unlikely to contribute a large amount of risk (NOAA Fisheries Service reported in 2002 that, at that time, there were 14 active scientific research permits for sea turtles). Numerous commercial and recreational fishing vessels also use these areas. Tanker imports and exports of crude and petroleum products into the GOM are projected to increase. Crude oil will continue to be tankered into the Gulf for refining from Alaska, California, and the Atlantic. Recreational pursuits can have an adverse effect on sea turtles through propeller and boat strike damage. Private vessels participate in high-speed marine events concentrated in the southeastern U.S. and are a particular threat to sea turtles. The magnitude of the impacts resulting from such marine events is not currently known (USDOC, NOAA Fisheries Service, 2002a).

Explosive discharges such as those used for MMS and COE structure removals can cause injury to sea turtles (Duronslet et al., 1986). Although sea turtles far from the site may suffer only disorientation, those near detonation sites could sustain fatal injuries. Injury to the lungs, intestines, and/or auditory system could occur. Other potential impacts include physical or acoustic harassment. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to explosive detonation are considered to be temporary effects. An estimated 738-775 and 3,487-3,495 explosive structure removals are projected to occur the WPA (**Table 4-5)** and CPA (**Table 4-6**), respectively, between 2007 and 2046.

To minimize the likelihood of removals occurring when sea turtles may be nearby, MMS issued guidelines for explosive platform removal to offshore operators. These guidelines include daylight-limited detonation, staggered charges, placement of charges 5 m (15 ft) below the seafloor, and pre- and post-detonation surveys of surrounding waters. With these existing protective measures (NOAA Fisheries Service Observer Program and daylight-only demolition) in place, "take" of sea turtles during structure removals has been limited. Additionally, MMS published a programmatic EA on explosive removal of structures in 2004 (USDOI, MMS, 2004) and petitioned NOAA Fisheries Service for programmatic rulemaking under the MMPA for Explosive Removal of Structures (EROS). The NOAA Fisheries Service Proposed Rule was published in the *Federal Register* on April 7, 2006. An ESA Section 7 consultation is in progress and the draft biological opinion is currently under review. In the interim, MMS consulted with NOAA Fisheries Service and, based on the Biological Opinions from those Section 7 consultations, issued NTL 2004-G06, "Structure Removal Operations," to provide lessees with mitigation and reporting requirements.

Sea turtles may be seriously impacted by marine debris. Trash and flotsam generated by the oil and gas industry and other users of the Gulf (Miller and Echols, 1996) is transported around the Gulf and Atlantic via oceanic currents (Plotkin and Amos, 1988; Hutchinson and Simmonds, 1992). Turtles that consume or become entangled in trash or flotsam may become debilitated or die (Heneman and the Center for Environmental Education, 1988). Monofilament line was reported the most common debris to entangle turtles (NRC, 1990). Fishing-related debris has been involved in about 68 percent of all cases of sea turtle entanglement (O'Hara and Iudicello, 1987). Floating plastics and other debris, such as petroleum residues drifting on the sea surface, accumulate in sargassum drift lines commonly inhabited by hatchling sea turtles. These materials could be toxic. In a review of worldwide sea turtle debris ingestion and entanglement, Balazs (1985) found that tar was the most common item ingested. Sea turtles, particularly leatherbacks, are attracted to floating plastic because it resembles food, such as jellyfishes. Ingestion of plastics sometimes interferes with food passage, respiration, and buoyancy and could reduce the fitness of a turtle or kill it (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; Lutz and Alfaro-Shulman, 1992). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of plastics at sea or in coastal waters.

Since sea turtle habitat in the Gulf includes both inshore and offshore areas, sea turtles are likely to encounter spills. Oil-spill estimates project that there will be numerous, frequent, small spills; many, infrequent, moderately sized spills; and infrequent, large spills occurring in coastal and offshore waters from 2007 to 2046 (**Table 4-16**). The probability that a sea turtle is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern Gulf will be exposed to residuals of spilled oils. Oil spills can adversely affect sea turtles by toxic ingestion or blockage of the digestive tract, inflammatory dermatitis, ventilatory disturbance, disruption or failure of salt gland function, red blood cell disturbances, immune responses, and displacement from important habitat areas (Witham, 1978; Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Sea turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988). In the past, tanker washings were a major source of oil in GOM waters (Van Vleet and Pauly, 1987). Although disturbances may be temporary, turtles chronically ingesting oil may experience organ degeneration. Exposure to oil may be fatal, particularly to juvenile and hatchling sea turtles. Hatchling and juvenile turtles are particularly vulnerable to contacting or ingesting oil because currents that concentrate oil spills also form the habitat mats in which these turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). There is also evidence that sea turtles feed in surface convergence lines, which could also prolong their contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). Fritts and McGehee (1982) noted that sea turtle eggs were damaged by contact with weathered oil released from the 1979 *Ixtoc* spill. Skin damage in turtles can result in acute or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection and debilitation (Vargo et al., 1986). Captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding oil, or became agitated and demonstrated short submergence levels (Lutcavage et al., 1995). Sea turtles sometimes pursue and swallow tarballs, and there is no conclusive evidence that wild turtles can detect and avoid oil (Odell and MacMurray, 1986; Vargo et al., 1986). A loggerhead turtle sighted during an aerial survey in the GOM surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have an indirect effect on the behavior of sea turtles. Assuming smell is necessary to sea turtle migration, oil-fouling of a nesting area may disturb imprinting of hatchling turtles or confuse turtles during their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985). The effect on reproductive success could therefore be significant.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location, oil type, oil dosage, impact area, oceanographic conditions, and meteorological conditions (NRC, 1985). Eggs, hatchlings, and small juveniles are particularly vulnerable upon contact (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Although many observed injuries and impacts to sea turtles were resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995).

Oil-spill-response activities, such as vehicular and vessel traffic in coastal areas of seagrass beds and live-bottom communities, can alter sea turtle habitat and displace sea turtles from these areas. Effects on seagrass and reef communities have been noted (reviewed by Coston-Clements and Hoss, 1983). Impacting factors include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some resulting impacts from cleanup could include interrupted or deferred nesting, crushed nests, entanglement in booms, and increased mortality of hatchlings because of predation during the extended time required to reach the water (Newell, 1995; Lutcavage et al., 1997; Witherington, 1999). The strategy for cleanup operations should vary, depending on season, recognizing that disturbance to nests may be more detrimental than oil (Fritts and McGehee, 1982). As mandated by the Oil Pollution Act of 1990 (**Chapter 1.3**), these areas are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil.

The chief areas used by Kemp's ridleys (coastal waters less than 18 m (59 ft) in depth) overlap with that of the shrimp fishery (Renaud, 1995). A major source of mortality for loggerhead and Kemp's ridleys is capture and drowning in shrimp trawls (Murphy and Hopkins-Murphy, 1989). Crowder et al. (1995) reported that 70-80 percent of turtle strandings were related to interactions with this fishery. Analysis of loggerhead strandings in South Carolina indicated a high turtle mortality rate from the shrimp fishery through an increase in strandings, and that the use of turtle excluder devices (TED's) could reduce strandings by 44 percent (Crowder et al., 1995). Caillouet et al. (1996) found a significant positive correlation between turtle stranding rates and shrimp fishing intensity in the northwestern GOM. The Kemp's ridley population, because of its distribution and small numbers, is at greatest risk. The NOAA Fisheries Service has required the use of TED's in southeast U.S. shrimp trawls since 1989. In response to increased numbers of dead sea turtles that washed up along the coasts of Texas, Louisiana, Georgia, and northeast Florida in 1994-1995, and coincident with coastal shrimp trawling activity, NOAA Fisheries Service increased enforcement efforts (relative to TED's), which decreased the number of strandings. After concerns arose that TED's were not adequately protecting larger sea turtles, NOAA Fisheries Service issued a Biological Opinion in 2002 that reported an estimated 62,000 loggerhead and 2,300 leatherback sea turtles had been killed as a result of interaction with the shrimp trawls. The Opinion also stated that 75 percent of the loggerhead sea turtles in the GOM were too large to be protected by the TED's. Subsequent regulation issued by NOAA Fisheries Service in 2003 required larger openings to better protect the larger sea turtles. The use of TED's is believed to reduce hard-shelled sea turtle captures by 97 percent. Even so, NOAA Fisheries Service estimated that 4,100 turtles may be captured annually by shrimp trawling, including 650 leatherbacks that cannot be released through TED's, 1,700 turtles taken in try nets, and 1,750 turtles that fail to escape through the TED. Other fisheries and fishery-related activities are important sources of mortality but are collectively only one-tenth as important as shrimp trawling (NRC, 1990). Turtles may be accidentally caught and killed in finfish trawls, seines, gill nets, weirs, traps, longlines, and driftnets (Hillestad et al., 1982; NRC, 1990; Witzell, 1992; Brady and Boreman, 1994). Various fishing methods used in State fisheries, including trawling, pot fisheries, fly nets, and gillnets are known to cause interactions with sea turtles. Florida and Texas have banned all but very small nets in State waters. Louisiana, Mississippi, and Alabama have also placed restrictions on gillnet fisheries within State waters, such that very little commercial gillnetting takes place in southeast waters. The State fishery for menhaden in the State waters of Louisiana and Texas is managed by the Gulf States Marine Fisheries Council and is not federally regulated for sea turtle take. Condrey and Rester (1996) reported a hawksbill take in the fishery, and other takes have been reported in the fishery between 1992 and 1999 (DeSilva, 1999).

Dredge-and-fill activities occur in many of the coastal areas inhabited by sea turtles. Operations range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation. Dredging operations affect turtles through accidental take and habitat degradation. The construction and maintenance of Federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill these species, presumably as the drag arm of the moving dredge overtakes the slower animal. Hopper dredging has caused turtle mortality in coastal areas (Slay and Richardson, 1988). Nearly all sea turtles entrained by hopper dredges are dead or dying when found (NRC, 1990). In addition to direct take, channelization of the inshore and nearshore areas can degrade foraging and migratory habitats via spoil dumping, degraded water quality/ clarity, and altered current flow.

Construction, vehicle traffic, beachfront erosion, and artificial lighting are activities that disturb sea turtles or their nesting beaches (Raymond, 1984; Garber, 1985). Traffic may compress nests and beach cleaning may compact or destroy nests, lowering hatching success (Coston-Clements and Hoss, 1983). Physical obstacles, such as deep tire tracks and expanded sand piles, may obstruct hatchling turtles from entering the sea or increase their stress and susceptibility to predation (Witham, 1995). Obstructions to the high watermark prevent nesting, and breakwalls are the most common and severe type of obstruction. Erosion of nesting beaches results in the loss of nesting habitat. Human interference has hastened erosion in many places. Artificial lighting from buildings, street lights, and beachfront properties may disorient hatchlings, as well as adults (Witherington and Martin, 1996). Females tend to avoid areas where beachfront lighting is most intense; turtles also abort nesting attempts more often in lighted areas. Hatchlings are attracted to lights and may delay their entry into the sea, thereby increasing their vulnerability to terrestrial predators. Condominiums sometimes block sunlight on nesting beaches, which could presumably affect sex ratios of hatchlings (the sex of a turtle is dependent on egg temperature) by increasing the number of males produced (discussed by Mrosovsky et al., 1995). Increased human activities, such as organized turtle watches, on nesting beaches may affect nesting activity (Fangman and Rittmaster, 1994; Johnson et al., 1996).

Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling water systems of electrical generating plants (NRC, 1990). At the St. Lucie nuclear power plant at Hutchinson Island, Florida, large numbers of green and loggerhead turtles have been captured in the seawater intake canal in the past several years. Annual capture levels from 1994 to 1997 ranged from almost 200 to almost 700 green turtles and from about 150 to over 350 loggerheads. Almost all of the turtles were caught and released alive; NOAA Fisheries Service estimated the survival rate at 98.5 percent or greater. Other power plants in Florida, Texas, and North Carolina have also reported low levels of sea turtle entrainment. An offshore intake structure may appear as a suitable resting place to some turtles, and these turtles may be subsequently drawn into a cooling system (Witham, 1995). Feeding leatherbacks may follow large numbers of jellyfish into the intake (Witham, 1995). Deaths can result from injuries sustained in transit through the intake pipe, from drowning in the capture nets, and perhaps from causes before entrainment. Thermal effluents from power plants may cause hatchlings to become disoriented and reduce their swimming speed (O'Hara, 1980). These effluents may also degrade seagrass and reef habitats (reviewed by Coston-Clements and Hoss, 1983).

Sand mining, beach renourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing nesting activities. The main causes of permanent nesting beach loss within the GOM are the reduction of sediment transport, rapid rate of relative sea-level rise, coastal construction and development, and recreational use of accessible beaches near large population centers. Crain et al. (1995) reviewed the literature on sea turtles and beach nourishment and found certain problems repeatedly identified. For nesting females, characteristics induced by nourishment can cause (1) beach compaction, which may decrease nesting success, alter nest-chamber geometry, and alter nest concealment; and (2) escarpments, which can block turtles from reaching nesting areas. For eggs and hatchlings, nourishment can decrease survivorship and affect development by altering beach characteristics such as sand compaction, gaseous environment, hydric environment, contaminant levels, nutrient availability, and thermal environment. Additionally, nests can be covered with excess sand if beach nourishment occurs in areas with incubating eggs.

The MMS has evaluated the use of sand resources for levee, beach, and barrier island restoration projects. Between 1995 and 2006, MMS provided over 23 million cubic yards of OCS sand for 17 coastal projects, restoring over 90 miles of national coastline. As the demand for sand for shoreline protection increases, OCS sand and gravel has become an increasingly important resource. For example, the Louisiana Coastal Area (LCA) Ecosystem Restoration Study estimated that about 60 million cubic yards of OCS sand from Trinity Shoal, Ship Shoal, and other sites will be needed for barrier island and shoreline restoration projects in the next 3-5 years. Use of these resources will require coordination with MMS for appropriate permits. Sea turtles are included in the potential impacts identified for sand dredging projects. Mitigation measures include requiring stipulations to protect sea turtles when it is determined that there is a likelihood of sea turtle presence within the area during the dredging operation and a trailing suction hopper dredge is used.

Human consumption of turtle eggs, meat, or byproducts occurs worldwide and depletes turtle populations (Cato et al., 1978; Mack and Duplaix, 1979). Commercial harvests are no longer permitted within continental U.S. waters, and Mexico has banned such activity (Aridjis, 1990). Since sea turtles are highly migratory species, the taking of turtles in subsistence and commercial sea turtle fisheries is still a concern.

Chronic pollution, including industrial and agricultural wastes and urban runoff, threatens sea turtles worldwide (Frazier, 1980; Hutchinson and Simmonds, 1991). Some turtle species have lifespans exceeding 50 years (Congdon, 1989; Frazer et al., 1989) and are secondary or tertiary consumers in marine environments, creating the potential for bioaccumulation of heavy metals (Hillestad et al., 1974; Stoneburner et al., 1980; Davenport et al., 1990), pesticides (Thompson et al., 1974; Clark and Krynitsky, 1980; Davenport et al., 1990), and other toxins (Lutz and Lutcavage, 1989) in their tissues. Organochlorine pollutants have been documented in eggs, juveniles, and adult turtles (Rybitski et al., 1995). Not all species accumulate residues at the same rate, for instance loggerheads consistently have higher levels of both PCB's and DDE than green turtles, and it has been hypothesized that the variation is because of dietary differences (George, 1997). Contaminants could stress the immune system of turtles or act as carcinogens indirectly by disrupting neuroendocrine functions (Colborn et al., 1993). In some marine mammals, chronic pollution has been linked with immune suppression, raising a similar concern for sea turtles.

In late 2002, the Deepwater Ports Act (DWPA) was modified to include the establishment of natural gas ports on the OCS (the Maritime Transportation Security Act of 2002, Public Law 107-295, November 2002). The DWPA requires an applicant to file a deepwater port license application with the Secretary of the U.S. Department of Transportation (USDOT). The USDOT Secretary has delegated the authority to process an application to the USCG and to the Maritime Administration (MARAD). To date, these agencies have received seven applications for LNG ports in the GOM. Six of the seven proposed receiving terminals are located within the CPA; Beacon Port is proposed for the WPA. Elevated concerns over impingement and entrainment of ichthyoplankton have led to development of monitoring requirements for intake and discharge of seawater at LNG ports in the GOM. These requirements include the collection of baseline data and the use of adaptive management practices. The USCG, working with NOAA and USEPA, formulated monitoring requirements that were included in the February 16, 2005, Record of Decision for the Gulf Landing LNG port. Subsequent GOM LNG port applications are required to follow similar monitoring requirements.

Sea turtles frequent coastal habitats such as algae and seagrass beds to seek food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980). Coastal areas are also used by juvenile Kemp's ridleys in Louisiana (Ogren, 1989) and Texas (Manzella and Williams, 1992). Juvenile hawksbill, loggerhead, and green turtles are typically found in coastal Texas waters (Shaver, 1991). Submerged vegetated areas may be lost or damaged by activities altering salinity, turbidity, or natural tidal and sediment exchange. Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage nesting beaches and coastal areas used by sea turtles (Agardy, 1990). Abnormally high tides and waves generated by storms may exact heavy mortality on sea turtles by washing them from the beach, inundating them with sea water, or altering the depth of sand covering them. Furthermore, excessive rainfall associated with tropical storms may reduce the viability of eggs. Turtles could be harmed in rough seas by floating debris (Milton et al., 1994). In addition, the hurricane season for the Caribbean and Western Atlantic (June 1-November 1) overlaps the sea turtle nesting season (March through November) (NRC, 1990). Nests are vulnerable to hurricanes during the incubation period as well as when hatchlings evacuate the nest. Hurricanes can cause mortality at turtle nests through immediate drowning from ocean surges, nest burial, or exhumation before hatching, and after hatching as a result of radically altered beach topography. The greatest surge effect from Hurricane Andrew in 1992 was experienced at beaches closest to the "eye" of the hurricane; egg mortality was 100 percent (Milton et al., 1994). In areas farther from the "eye," the surge was lower and mortality was correspondingly decreased. Sixty-nine percent of eggs on Fisher Island in Miami, Florida, did not hatch after Hurricane Andrew and appeared to have "drowned" during the storm (Milton et al., 1994). Further mortality occurred when surviving turtles suffocated in nests situated in the beach zone where sand had accreted. This subsequent mortality may be reduced if beach topography is returned to normal and beach debris removed after a hurricane (Milton et al., 1994). Species that have limited nesting ranges, such as the Kemp's ridley, would be greatly impacted if a hurricane made landfall at its nesting beach (Milton et al., 1994). Hurricane Erin in 1995 caused a 40.2 percent loss in hatchling production on the southern half of Hutchinson Island (Martin, 1996). A beach can be completely closed to nesting after a hurricane. For example, at Buck Island Reef National Monument on St. Croix, after Hurricane Hugo in 1989, 90 percent of the shoreline trees on the North Shore were blown down parallel to the water, blocking access to nesting areas (Hillis, 1990). "False crawl ratios" for hawksbill turtles doubled after the hurricane, mostly because of fallen trees and eroded root tangles blocking nesting attempts (Hillis, 1990). Other direct impacts of Hurricane Hugo on sea turtle habitats include destruction of coral reef communities important to hawksbill and green turtles. Nooks and crannies in the reef used by these turtles for resting were destroyed in some areas (Agardy, 1990). Seagrass beds, which are important foraging areas for green turtles, were widely decimated in Puerto Rico (Agardy, 1990). Indirect effects (contamination of food or poisoning of reef-building communities) on the offshore and coastal habitats of sea turtles include pollution of nearshore waters from storm-associated runoff.

Tropical storms and hurricanes are a normal occurrence in the Gulf and along the coast. Generally, the impacts have been localized and infrequent. However, in the last two years the GOM has been extremely hard hit by very powerful hurricanes. Few areas of the coast have not suffered some damage in 2004-2005 and activities in the Gulf have also been severely impacted. In 2004, Hurricane Ivan took a large toll on oil and gas structures and operations in the Gulf and caused widespread damage to the Alabama-Florida Panhandle coast. In 2005, Hurricanes Katrina, Rita, and Wilma reached Category 5 strength in the GOM. These storms caused damage to all five of the Gulf Coast States and damage to structures and operations both offshore and onshore. The actual impacts of these storms on the animals in the Gulf, and the listed species and critical habitat in particular, have not yet been determined and, for the most part, may remain very difficult to quantify. However, some impacts, such as loss of beach habitat, are known to have occurred and will impact sea turtles that would have used those areas for nesting beaches. About 50 sea turtle nests along the Alabama coast are known lost. All 10 of the nests at Bon Secour National Wildlife Refuge in Alabama were destroyed. Breton Wildlife Refuge, part of the Chandeleur Islands off of Louisiana, lost approximately 50 percent of its land mass to Hurricane Katrina (Di Silvestro, 2006). Similar habitat loss is expected for the chain of islets. The Chandeleur Islands are known to be very important loggerhead nesting habitat. Oil, gas, and chemical spills from damaged and destroyed structures and vessels may have impacted sea turtles (though no major oil spills were reported, several lesser spills are known to have occurred). Increased trash and debris in both offshore and inshore habitats affected sea turtles. About 200 loggerhead hatchlings could not get across the accumulated seagrass and debris washed ashore at Hutchinson Island, Florida, days after Hurricane Katrina hit. Most of the hatchlings were recovered and later released in the ocean (CBS News, 2005). Increased runoff and silting from wind and rain may have affected water quality. The NOAA Fisheries Service granted shrimp trawlers a series of 30-day exemptions from Federal TED requirements in some State and Federal waters off Alabama, Mississippi, and Louisiana. The exemptions were granted due to debris in the water that made trawling with TED's "impracticable". Although shrimpers were to limit tow times in lieu of using TED's, this exemption may have adversely impacted some individual sea turtles. Not only are the impacts themselves difficult to assess, but the seasonal occurrence of impacts from hurricanes is also impossible to predict. Generally, the offshore species and the offshore habitat are not expected to have been severely affected in the long-term. However, species that occupy more nearshore habitats and those that utilize nearshore habitats (sea turtle nesting) may have suffered more long-term impacts.

Summary and Conclusion

Activities considered under the cumulative scenario may harm sea turtles and their habitats. Those activities include structure installation, dredging, water quality and habitat degradation, OCS-related marine debris, vessel traffic, seismic surveys, explosive structure removals, oil spills, oil-spill-response activities, natural catastrophes, pollution, dredge operations, vessel collisions, commercial and recreational fishing, human consumption, beach lighting, and power plant entrainment. Sea turtles could be killed or injured by chance collision with service vessels or eating marine debris, particularly plastic items, lost from OCS structures and service vessels. It is expected that deaths as a result of structure removals would rarely occur because of mitigation measures. The presence of, and noise produced by, service vessels and by the construction, operation, and removal of drill rigs may cause physiological stress and make animals more susceptible to disease or predation, as well as disrupt normal activities. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification. Oil spills and oil-spill-response activities are potential threats that may be expected to cause turtle deaths. Contact with, and consumption of oil and oil-contaminated prey, may seriously impact turtles. Sea turtles have been seriously harmed by oil spills in the past. The majority of OCS activities are estimated to be sublethal (behavioral effects and nonfatal exposure to intake of OCS-related contaminants or debris). Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or productivity, resulting in either acute or gradual population declines. However, mitigations currently in place have, and will continue to, minimize sea turtle impacts. Natural phenomenon, such as tropical storms and hurricanes, are impossible to predict, but they will occur in the GOM. Generally, the offshore species and the offshore habitat are not expected to be severely affected in the long-term. However, species that occupy more nearshore habitats and those that use nearshore habitats (sea turtle nesting) may suffer more long-term impacts. The incremental contribution of a proposed action to the numerous, cumulative impacts to sea turtles is not expected to be significant, especially due to migitations currently in place.

4.5.7. Impacts on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

This cumulative analysis considers the effects of OCS-related and non-OCS-related impact-producing factors related to (1) oil and gas operations for the proposed multisale actions, prior and future OCS sales, and import tankering; (2) alteration and destruction of habitat by oil-spill cleanup with accompanying motorized traffic, dredge-and-fill activities by residential and commercial coastal construction and associated vehicular traffic, and natural catastrophes; (3) predation and competition in the ecological community; and (4) beach trash and debris. The effects from these major impact-producing factors are described below. This analysis incorporates the discussion of the effects from these impact-producing factors on beach mice in **Chapters4.2.2.1.7 and 4.4.7**.

Oil spills can result from import tankering, barging, platform accidents, pipeline malfunctions, and other sources (**Table 4-13**). Spilled oil can cause skin and eye irritation, asphyxiation from inhalation of toxic fumes, food reduction, food contamination, increased predation, and displacement from preferred habitat. Contamination of food (for example, oiling of sea oat grains) may result in oil ingestion or make food tasteless or distasteful. The effects of oil that contacts a beach mouse are mentioned above. A slick cannot wash over the foredunes into beach mouse habitat unless carried by a heavy storm swell. Given the probabilities of a spill occurring, persisting long enough to reach beach mouse habitat, arriving ashore coincidentally with a storm surge, and affecting beach mice, impacts of oil spills on beach mice from the cumulative scenario are expected to be low.

In the event of an oil spill, protection efforts to prevent contact of spilled oil with these areas are mandated by the Oil Pollution Act of 1990. Vehicular traffic associated with oil-spill cleanup activities may degrade preferred habitat and cause displacement from these areas if not propely regulated.

Present beach mice habitat is no longer of optimal quality because of historical beach erosion, construction, and tropical storm damage. Coastal construction can be expected to threaten beach mouse populations on a continual basis. Beach mice have existed in an environment subject to recurring hurricanes, but tropical storms and hurricanes are now considered to be a primary factor in the beach mouse's decline. It is only within the last 20-30 years that the combination of habitat loss due to beachfront development, isolation of remaining beach mouse habitat blocks and populations, and the destruction of remaining habitat by hurricanes have increased the threat of extinction of several subspecies of beach mice. Natural catastrophes including storms, floods, droughts, and hurricanes may substantially reduce or eliminate beach mice habitat. Some of these are expected to occur and periodically contact beach mouse habitat with direct and indirect effects on beach mice.

Predation from both feral and nonferal domestic cats and dogs and competition with common house mice may also reduce and disturb their populations, but estimates of this mortality are unreliable (USDOI, FWS, 1987; Humphrey and Frank, 1992).

Trash and debris may be mistakenly consumed by beach mice or entangle them. This problem may have increased following Hurricanes Ivan and Katrina because the storms washed large amounts of debris into the dune habitats. In addition, the reduction of food sources due to storm stress could lead animals to consume items not normally in their diet. Cleanup efforts to remove storm debris could result in serious negative impacts to beach mouse habitat if not properly regulated.

The beach mouse has a maximum expected lifespan of one year, and the effects of disturbances are not expected to last for more than one or two generations, provided some relict population survives.

Summary and Conclusion

Cumulative activities have a potential to harm or reduce the numbers of Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice. Those activities include oil spills, alteration and reduction of habitat, predation and competition, and consumption of beach trash and debris. Most multisale-related spills, as well as oil spills stemming from import tankering and prior and future lease sales, are not expected to contact beach mice or their habitats. The expected incremental contribution of a proposed action (as analyzed in **Chapter 4.4.7**) to the cumulative impacts is negligible. Cumulative activities posing the greatest potential harm to beach mice are non-OCS activities (beach development and coastal spills) and natural catastrophes (hurricanes) which, in combination, could potentially deplete some beach mice populations to unsustainable levels.

4.5.8. Impacts on Coastal and Marine Birds

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions; prior and future OCS sales; State oil and gas activity; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities that may occur and adversely affect populations of nonendangered/nonthreatened and endangered/threatened birds. Air emissions; degradation of water quality; oil spills and spill-response activities; aircraft and vessel traffic and noise, including OCS helicopter and service-vessels; habitat loss and modification resulting from coastal construction and development; OCS pipeline landfalls and coastal facility construction; and trash and debris are OCS-related sources of potential adverse impacts. Non-OCS impact-producing factors include habitat degradation; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. This analysis incorporates the discussion of the effects from these impact-producing factors on coastal and marine birds in **Chapters 4.2.1.1.7, 4.2.2.1.8, and 4.4.8** with additional information as cited.

Chapters 4.2.1.1.1, 4.2.2.1.1, and 4.5.1 consider air emissions including the amount of sulfur dioxide expected to be released due to a proposed action as well as from prior and future OCS sales, and State oil and gas activity. These emissions may adversely affect coastal and marine birds. Pollutant emissions into the atmosphere from the activities under the cumulative analysis are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Onshore impact on air quality from emissions under the OCS cumulative analysis is estimated to be within both Class I and Class II PSD allowable increments as applied to the respective subareas. Emissions of pollutants into the atmosphere under the cumulative analysis are projected to have little effect on onshore air quality because of the atmospheric regime, the emission rates, and the distance of these emissions from the coastline. These judgments are based on average steady state conditions and the dispersion equation for concentration estimates; however, there will be days of low mixing heights and wind speeds that could further decrease air quality. These conditions are characterized by fog formation, which in the Gulf averages about 30-40 days a year, mostly during winter. Impacts from offshore sources are reduced in winter because the frequency of onshore winds decreases and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} under the cumulative analysis are estimated to be less than Class I and Class II PSD allowable increments for the respective subareas per both the steady state and plume dispersion analyses, and are below concentrations that could harm coastal and marine birds. Indirect impacts on coastal and marine birds due to direct impacts on air quality under the cumulative analysis will have a negligible effect on coastal and marine birds.

Degradation of coastal and inshore water quality resulting from factors related to the proposed actions plus those related to prior and future OCS sales; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities is expected to impact coastal and marine birds. The effects of the cumulative activities scenario on coastal water quality are analyzed in detail in **Chapter 4.5.2.1**. There exists a wide variety of contaminant inputs into coastal waters bordering the Gulf of Mexico. The dominant pollution source is the large volume of water from the Mississippi River, which drains over two-thirds of the contiguous United States. Major activities that have added to the contamination of Gulf coastal waters include the petrochemical industry, agriculture, forestry, urban expansion, extensive dredging operations, municipal sewerage treatment processes, marinas and recreational boating, maritime shipping, and hydromodification activities. Not as significant are large commercial waste disposal operations, livestock farming, manufacturing industry activities, power plant operations, and pulp and paper mills. Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. Projected large oil spills represent an acute significant impact to coastal waters while small spills serve as a low-level, chronic source of petroleum contamination to regional coastal water quality.

Coastal and marine birds will likely experience chronic physiological stress from sublethal exposure to or intake of contaminants or discarded debris. This will cause disturbances and displacement of single birds or flocks. Chronic sublethal stress is often undetectable in birds. It can serve to weaken individuals (especially serious for migratory species) making them susceptible to infection and disease. The extensive oil and gas industry operating in the Gulf area has caused low-level, chronic, petroleum contamination of coastal waters. Lethal effects are expected primarily from uncontained inshore oil spills and associated spill response activities in wetlands and other biologically sensitive coastal habitats. Primary physical effects are oiling and the ingestion of oil, and secondary effects are the ingestion of oiled prey. Recruitment of birds through successful reproduction is expected to take up to many years, depending upon the species and existing conditions. In **Chapter 4.4.8,** generic effects of oil on raptors, pelicans, and plovers are discussed.

Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. The FAA (Advisory Circular 91-36C) and corporate helicopter policy states that helicopters must maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Generic importance of the flight altitude regulation to birds is discussed in **Chapters 4.2.1.8, 4.2.2.1.8, and 4.4.8**. The net effect of OCS-related flights on coastal and marine birds is expected to result in sporadic disturbances, which may result in displacement of localized groups. During nesting periods, this could ultimately result in some reproductive failure from nest abandonment or predation on eggs and young when a parent is flushed from a nest.

Under the cumulative activities scenario, 167,850-215,200 OCS-related, service-vessel trips are projected to occur annually. Service vessels will use selected nearshore and coastal (inland) navigation waterways, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways diminishes the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. It is expected that service-vessel traffic will seldom disturb populations of coastal and marine birds existing within these areas. Recreational vessel traffic is a much greater source of impact to birds in coastal habitats. These vessels are, in most cases, not required to comply with strict speed/wake restrictions (small recreational fishing boats, ski boats, etc.) often flush coastal and marine birds from feeding, resting, and nesting areas. Such disturbances displace local groups from these preferred habitats and could lead to abandonment of the areas in general or reproductive failure. Disturbance may result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity. It is estimated that the effects of non-OCS vessel traffic on birds within coastal areas are substantial.

Historic census data shows that many of these species are declining in numbers and are being displaced from areas along the coast (and elsewhere) as a result of the encroachment of their preferred habitat(s) by the aforementioned sources. As these birds move to undisturbed areas of similar habitat, their presence may create or augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. Under the cumulative activities scenario, factors contributing to coastal landloss or modification include construction of approximately 32-47 OCS-related pipeline landfalls resulting in up to 64-94 km (40-58 mi) of onshore pipeline, and potentially 14 gas processing plants as well as other facilities. The contribution of development from urban and other industrial growth will be substantial, causing both the permanent loss of lands and increased levels of disturbance associated with new construction and facilities.

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. Many species will readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials may lead to permanent injuries and death. Much of the floating material discarded from vessels and structures offshore drifts ashore or remains within coastal waters. These materials include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest damage to birds. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989. Despite these regulations, quantities of plastic materials are accidentally discarded and lost in the marine environment, and so remain a threat to individual birds within these areas.

Non-OCS impact-producing factors include habitat degradation; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. Coastal storms and hurricanes can often cause deaths to coastal birds through high winds; associated flooding destroys active nests. Nesting territories and colonial bird rookeries with optimum food and/or nest-building materials may also be lost. Elevated levels of municipal, industrial, and agricultural pollutants in coastal wetlands and waters expose resident birds to chronic physiological stress. Collisions with power lines and supporting towers can occur during inclement weather and during periods of migration, often causing death or permanent injury to birds (Avery et al., 1980; Avian Power Line Interaction Committee, 1994). Vital habitat needs to be protected so that the life-support system continues for the birds and their prey. Habitat alteration has the potential to disrupt social behavior, food supply, and health of birds that occur in the Gulf of Mexico. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas or migratory routes. Commercial fisheries may accidentally entangle and drown or injure birds during fishing operations or by lost and discarded fishing gear. Competition for prey species may also occur between birds and fisheries.

Summary and Conclusion

Activities considered under the cumulative activities scenario will detrimentally affect coastal and marine birds. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) and will usually cause temporary disturbances and displacement of localized groups inshore. The net effect of habitat loss from oil spills, new construction, and maintenance and use of pipeline corridors and navigation waterways will alter species composition and reduce the overall carrying capacity of disturbed area(s) in general.

The incremental contribution of a proposed action (**Chapters 4.2.1.1.8, 4.2.2.1.1.10, and 4.4.10**) to the cumulative impact is negligible because the effects of the most probable impacts, such as sale-related operational discharges and helicopters and service-vessel noise and traffic, are estimated to be sublethal and some displacement of local individuals or groups may occur. It is expected that there will be little interaction between OCS-related oil spills and coastal and marine birds.

The cumulative effect on coastal and marine birds is expected to result in a discernible decline in the numbers of birds that form localized groups or populations, with associated change in species composition and distribution. Some of these changes are expected to be permanent, as exemplified in historic census data, and to stem from a net decrease in preferred and/or critical habitat.

4.5.9. Impacts on Endangered and Threatened Fish

4.5.9.1. Gulf Sturgeon

This cumulative analysis considers the effects of impact-producing factors related to (1) oil spills involving the proposed actions and prior and future OCS sales; (2) dredge-and-fill operations and natural catastrophes that alter or destroy habitat, and (3) commercial fishing on the Gulf sturgeon. Sections providing supportive material for the Gulf sturgeon analysis include **Chapters 3.2.8** (description of Gulf sturgeon), **4.4.1.1.3.1** (offshore oil spills), **4.4.1.1.3.2** (coastal oil spills), **4.1.1-4.1.2** (other major onshore/ coastal activities), and **4.1.3.4** (non-OCS oil spills).

The Gulf sturgeon can be impacted by activities such as oil spills, alteration, and destruction of habitat, and commercial fishing. The effects from contact with spilled oil will be sublethal and last for less than 1 month.

Extant occurrences of Gulf sturgeon in 1993 extended from Lake Pontchartrain in southeastern Louisiana to Charlotte Harbor in western Florida (USDOI, FWS and Gulf States Marine Fisheries Commission, 1995). Although spawning may occur from the Pearl River in western Mississippi eastward, the most important spawning populations occur within the Florida Panhandle in the Apalachicola and Suwannee Rivers (Patrick, personal communication, 1996). Spawning grounds are located upriver in bottomland hardwood forested wetlands that are flooded during winter, not within coastal wetlands (Barkuloo, 1988; Clugston, 1991).

The direct effects of spilled oil on Gulf sturgeon occur through the ingestion of oil or oiled prey and the uptake of dissolved petroleum through the gills by adults and juveniles. Contact with or ingestion/ absorption of spilled oil by adult Gulf sturgeon can result in mortality or sublethal physiological impact, especially irritation of gill epithelium and disturbance of liver function.

For spills greater than or equal to 1,000 bbl, concentrations of oil below the slick are within the ranges that cause sublethal effects on marine organisms. The maximum observed concentration of 1.5 ppm was observed at depth of 2 m below the slick from the 1979 *Ixtoc* blowout (McAuliffe, 1987). This value is within the range of LC_{50} values for many marine organisms; such values are typically 1-100 ppm for adults and subadults (Connell and Miller, 1980; Capuzzo, 1987). However, when exposure time beneath accidental spills, hydrocarbon composition, and the change in this composition during weathering are considered, exposure doses (measured as ppm-hr) are assumed to be far less than doses reported to cause even sublethal effects (McAuliffe, 1987). Given the low probability of occurrence, low probability that the low-population Gulf sturgeon would occur in the specific area when a spill occurs, small likelihood of contact of a surface oil slick with a demersal fish and its benthic habitat, and minimal concentrations of toxic oil relative to levels that would be toxic to adult or subadult Gulf sturgeon, the impacts of spilled oil on this endangered subspecies are expected to be very low.

It is expected that the extent and severity of effects from oil spills will be lessened by active avoidance of oil spills by adult sturgeon. Sturgeons are demersal and would forage for benthic prey well below an oil slick on the surface. Adult sturgeon only venture out of the rivers into the marine waters of the Gulf for roughly three months during the coolest weather. This reduces the likelihood of sturgeon coming into contact with oil. It is expected that contact will cause sublethal irritation of gill epithelium and an increase in liver function for less than a month. Tarballs resulting from the weathering of oil "are found floating at or near the surface" (NRC, 2002) with no effects expected to demersal fishes such as the Gulf sturgeon.

Natural catastrophes and non-OCS activities such as dredge-and-fill may destroy Gulf sturgeon habitat. Natural catastrophes including storms, floods, droughts, and hurricanes can result in substantial habitat damage. Loss of habitat is expected to have a substantial effect on the reestablishment and growth of Gulf sturgeon populations.

Dredge-and-fill activities occur throughout the nearshore areas of the United States. They range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation. Non-OCS operations, such as dredge-and-fill activities and natural catastrophes, indirectly impact Gulf sturgeon through the loss of spawning and nursery habitat.

Commercial fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may impact species other than the target species. For example, Gulf sturgeons are a small part of the shrimp bycatch. It is estimated that for every 0.5 kilograms (kg) of shrimp harvested, 4 kg of bycatch is discarded (Sports Fishing Institute, 1989). The death of several Gulf sturgeon is expected from commercial fishing.

Substantial damage to Gulf sturgeon critical habitat is expected from inshore alteration activities and natural catastrophes. The FWS (50 CFR 17) identified the following activities that may destroy or adversely modify Gulf sturgeon critical habitat:

(1) Actions that would appreciably reduce the abundance of riverine prey for larval and juvenile sturgeon, or of estuarine and marine prey for juvenile and adult Gulf sturgeon, within a designated critical habitat unit. Such actions include dredging, dredged material disposal, channelization, in-stream mining, and land uses that cause excessive turbidity or sedimentation.

(2) Actions that would appreciably reduce the suitability of Gulf sturgeon spawning sites for egg deposition and development within a designated critical habitat unit. Such actions include impoundment, hard-bottom removal for navigation channel deepening, dredged material disposal, in-stream mining, and land uses that cause excessive sedimentation.

(3) Actions that would appreciably reduce the suitability of Gulf sturgeon riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, believed necessary for minimizing energy expenditures and possibly for osmoregulatory functions. Such actions include dredged material disposal upstream or directly within such areas and other land uses that cause excessive sedimentation.

(4) Actions that would alter the flow regime (the magnitude, frequency, duration, seasonality, and rate-of-change fresh water discharge over time) of riverine critical habitat unit such that appreciably impaired for the purposes Gulf sturgeon migration, resting, staging, breeding site selection, courtship, egg fertilization, egg deposition, and egg development. Such actions include impoundment, water diversion, and dam operations.

(5) Actions that would alter water quality within a designated critical habitat unit, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability. Such actions include dredging; dredged material disposal; channelization; impoundment; in-stream mining; water diversion; dam operations; land uses that cause excessive turbidity; and release of chemicals, biological pollutants, or heated effluents into surface water or connected groundwater via point sources or dispersed nonpoint sources.

(6) Actions that would alter sediment quality within a designated critical habitat unit such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability. Such actions include dredged material disposal, channelization, impoundment, in-stream mining, land uses that cause excessive sedimentation, and release of chemical or biological pollutants that accumulate in sediments.

(7) Actions that would obstruct migratory pathways within and between adjacent riverine, estuarine, and marine critical habitat units. Such actions include dam

construction, dredging, point-source pollutant discharges, and other physical or chemical alterations of channels and passes that restrict Gulf sturgeon movement.

If any of the above were to occur and result in damage to Gulf sturgeon critical habitat, it is expected that the Gulf sturgeon will experience a decline in population sizes and a displacement from their current distribution that will last more than one generation.

Summary and Conclusion

The Gulf sturgeon and its critical habitat can be impacted by activities considered under the cumulative scenario, activities such as oil spills, alteration and destruction of habitat, and commercial fishing. The effects from contact with spilled oil will be sublethal and last for less than one month. Substantial damage to Gulf sturgeon critical habitat is expected from inshore alteration activities and natural catastrophes. As a result, it is expected that the Gulf sturgeon will experience a decline in population sizes and a displacement from their current distribution that will last more than one generation. Deaths of adult sturgeon are expected to occur from commercial fishing. The incremental contribution of a proposed action (as analyzed in **Chapter 4.2.1.9**) to the cumulative impact is negligible because the effect of contact between sale-specific oil spills and Gulf sturgeon is expected to be sublethal and last less than one month.

4.5.10. Impacts on Fish Resources and Essential Fish Habitat

This cumulative analysis considers activities that could occur and adversely affect fish resources and EFH in the northern GOM during the years 2007-2046. These activities include effects of the OCS Program (a proposed action, and prior and future OCS lease sales), State oil and gas activity, coastal development, crude oil imports by tanker, commercial and recreational fishing, and natural phenomena. Specific types of impact-producing factors considered in this cumulative analysis include coastal environmental degradation; marine environmental degradation; commercial and recreational fishing techniques or practices; hypoxia; red or brown tides; hurricanes; removal of production structures; petroleum spills; subsurface blowouts; pipeline trenching; and offshore discharges of drilling muds and produced waters.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages for marine species (as described in **Chapter 3.2.8**), EFH for the GOM includes all coastal and marine waters and substrates from the shoreline to an offshore depth of 183 m (100 fathoms) for most managed species. The effects of cumulative actions on coastal wetlands and coastal water quality are analyzed in detail in **Chapters 4.5.3.2 and 4.5.2.1**, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation. The effects of cumulative actions on offshore live bottoms and marine water quality are analyzed in detail in **Chapters 4.5.4.1.1 and 4.5.2.2**, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation. The direct and/or indirect effects from cumulative coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Conversion of wetlands for agricultural, residential, and commercial uses has been substantial. The trend is projected to continue into the future, although at a slower rate in consideration of regulatory pressures. The most serious impact to EFH is the cumulative effects on wetlands that are occurring at an ever-increasing rate as the Gulf Coast States' populations increase (GMFMC, 1998 and 2004). Residential, commercial, and industrial developments are directly impacting EFH by dredging and filling coastal areas or by affecting the watersheds.

The cumulative impacts of pipelines to wetlands are described in **Chapter 4.5.3.2.** Permitting agencies require mitigation of many of these impacts. Unfortunately, many of these efforts are not as productive as intended.

Canal dredging primarily accommodates commercial, residential, and recreational development. Increased population and commercial pressures on the coasts of Texas, Louisiana, Mississippi, and Alabama are also causing the expansion of ports and marinas there. Where new channels are dredged, wetlands would be adversely impacted by the channel, disposal of dredged materials, and the development that it attracts.

The continuing erosion of waterways maintained by COE is projected to adversely impact productivity of wetlands along channel banks. Expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment export, and habitat conversion can be significant in basins with low topographic relief, as seen in deltaic Louisiana. Secondary impacts are projected to generate the loss of wetlands over the next 30-40 years, primarily in Louisiana. Additional details of cumulative wetlands loss, including impacts from major storms such as the hurricanes of 2005, are detailed in **Chapter 4.5.3.2**.

Other factors that impact coastal wetlands include marsh burning, marsh-buggy/airboat traffic, and well-site construction. The practice of marsh buggy/airboat use in marsh areas is far less common than in years past. Tracks left by marsh buggies open new routes of water flow through relatively unbroken marsh and can persist for up to 30 years, thereby inducing and accelerating erosion and sediment export. Well-site construction activities include board roads, ring levees, and impoundments.

Conversion of wetland habitat is projected to continue in the foreseeable future. Within the northern GOM coastal areas, river channelization and flood protection have greatly restricted the most effective wetland creation activities. Flood control has fostered development, which has impacted wetlands the most and reduced their area. Recent storm damage has radically altered the perception of "flood control" in southern Louisiana, and the future loss of wetlands from additional development will likely be substantially slowed for many years.

The present number of major navigation canals appears to be adequate for the OCS Program and most other developments. Some of these canals may be deepened or widened. Navigation canal construction would continue in coastal Louisiana, particularly in association with growing port facilities such as Port Fourchon, and would be an important cause of wetland loss there. Secondary impacts of canals to wetlands would continue to cause impacts.

The incremental contribution of a proposed action (**Chapter 4.2.1.1.3.2** for the WPA, **Chapter 4.2.2.1.3.2** for the CPA, and **Chapter 4.4.3.2** for accidental events) would be a very small part of the cumulative impacts to wetlands. Offshore live bottoms would not be impacted.

The coastal waters of Texas, Louisiana, Mississippi, Alabama, and the Florida Panhandle are expected to continue to experience nutrient over enrichment, periods of low-dissolved oxygen, and toxin and pesticide contamination, resulting in the loss of both commercial and recreational uses of the affected waters. Fish kills, shellfish-ground closures, and restricted swimming areas would likely increase in numbers over the next 30-40 years (although some areas have seen improvements and re-opened for swimming, such as Lake Pontchartrain). Degradation of water quality is expected to continue because of contamination by point- and nonpoint-source discharges and spills due to eutrophication of waterbodies, primarily due to runoff and hydrologic modifications. Contamination of coastal waters by natural and manmade sources and accidental spills derived from both rural and urban sources would be both localized and pervasive. Increased turbidity from extensive dredging operations projected to continue within the coastal zone constitutes another type of pollution. Contamination from oil and hazardous substance spills should be primarily localized and not long term enough to preclude designated uses of the waters for more than short periods of time.

The incremental contribution of a proposed action (**Chapter 4.2.1.1.2.1** for the WPA and **Chapter 4.2.2.1.2.1** for the CPA) would be a very small part of the cumulative impacts to coastal water quality. Localized, minor degradation of coastal water quality is expected from a proposed action within the immediate vicinity of the waterbodies proximate to the proposed service bases, commercial waste-disposal facilities, and gas processing plants as a result of routine effluent discharges and runoff. Only a very small amount of dredging would occur as a result of a proposed action.

Non-OCS sources of impacts on biological resources and the structure of live bottoms include natural disturbances (e.g., turbidity, disease, and storms), anchoring by recreational and commercial vessels, and commercial and recreational fishing. These impacts may result in severe and permanent mechanical damage at various scales to live-bottom communities. The impacts of the 2005 hurricanes to the shallowest topographic features are being investigated in 2006. Some physical damage from wave energy is known to have occurred to numerous coral heads at the Flower Garden Banks.

The OCS-related cumulative activities (other than those related to a proposed action) could impact the biological resources and the structure of live bottoms by the anchoring of vessels, emplacement of structures (drilling rigs, platforms, and pipelines), sedimentation (operational waste discharges, pipeline emplacement, explosive removal of platforms, and blowouts), and chemical contamination (produced water, operational waste discharges, and petroleum spills). The Live Bottom (Pinnacle Trend) Stipulation (in the CPA), and the Topographic Features Stipulation (in the CPA and WPA) would prevent most of the potential impacts on live-bottom communities and EFH from the OCS Program and from bottom-disturbing activities (anchoring, structure emplacement and removal, pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, produced waters), and blowouts. Recovery from impacts caused by unregulated operational discharges or an accidental blowout would take several years. In the unlikely event of an offshore spill, the biological resources of hard/live bottoms would remain unharmed as the spilled substances could, at the most, reach the seafloor in minute concentrations. These minute quantities may cause very short-term sublethal effects (changes in physiology) in benthic organisms that would recover quickly.

Surface oil spills from OCS Program-related activities would have the greatest chance of impacting high relief live bottoms (includes topographic features and pinnacles) located in depths less than 20 m (66 ft) (mostly sublethal impacts). Most of the pinnacle trend is well mapped and described (**Chapter 3.2.2.1.1**, Live-Bottom (Pinnacle Trend)). All pinnacle features are located deeper than 20 m (66 ft); the shallowest described is below 60 m (197 ft). Only four named topographic features reach depths of less than 20 m (66 ft)—East and West Flower Garden Banks, Sonnier Bank, and Stetson Bank. Subsurface spills (pipeline spills) could cause localized, sublethal (short-term, physiological changes) impacts on the live bottoms; however, such events would be highly unlikely since the protective lease stipulations would prevent oil lines from being installed in the immediate vicinity of high-relief live bottoms. The impact of OCS-related activities on the live bottoms of the cumulative activity area would probably be slight because community-wide impacts should not occur.

The incremental contribution of a proposed action to the cumulative impacts on fisheries and EFH (as analyzed in **Chapters 4.2.1.1.8, 4.2.2.1.10, and 4.4.10**) would be small. A proposed action would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes and sedimentation/sediment resuspension. Other activities of a proposed action potentially contributing to regional impacts would be the effects of petroleum spills and anchoring. The extent of these impacts would be limited by the implementation of the protective lease stipulations and the depths of all but three high-relief live bottom habitats (>20 m (66 ft)).

Municipal, agricultural, and industrial coastal discharges and land runoff would impact the health of marine waters. This degradation would cause short-term loss of the designated uses of some shallow offshore waters due to hypoxia and red or brown tide impacts and to levels of contaminants in some fish exceeding human health standards. Coastal sources are assumed to exceed all other sources, with the Mississippi River continuing to be the major source of contaminants to the north-central GOM area. Even with the increased understanding of the agricultural sources of nutrients moving down the Mississippi River and causing the hypoxic areas off Louisiana every year, there has been little accomplished leading to reductions in those sources. In the case of mercury, the amount of mercury entering the GOM from all offshore oil and gas facilities contributes only 0.3 percent of the mercury coming from the air and Mississippi River (Neff, 2002).

Offshore vessel traffic and OCS operations would contribute in a small way to regional degradation of offshore waters through spills and waste discharges. All spill incidents (OCS and others) and activities increasing water-column turbidity are assumed to cause localized water quality changes for up to three months for each incident. The incremental contribution of a proposed action to degradation of marine water quality would be small.

It is expected that coastal and marine environmental degradation from the OCS Program and non-OCS activities would affect fish populations and EFH. The impact of coastal and marine degradation is expected to cause no more than a 10 percent decrease in fish populations or EFH. The incremental contribution of a proposed action to these cumulative impacts would be small and almost undetectable.

Fishing

Commercial fishing activities that could impact live bottoms would include trawl fishing and trap fishing. With the exception of localized harvesting techniques, most wild-caught shrimp are collected using bottom trawls—nets towed along the seafloor—held apart with heavy-bottom sled devices called "doors" made of wood or steel. In addition to the nonselective nature of bottom trawls, they can cause extreme damage to bottom habitat as they drag. Trawls pulled over the bottom disrupt the communities that live on and just below the surface and also increases turbidity of the water (GMFMC, 1998). Trawling typically would avoid areas of topographic relief and associated live bottom because of likely gear damage or loss.

Throughout the Gulf Coast, commercial trap fishing is used for the capture of reef fish, while commercial and recreational trap fishing is used for the capture of spiny lobster, stone crab, and blue crab. The use of fish traps will be phased out by 2007. Reef fish traps are primarily constructed of vinyl-covered wire mesh and include a tapered funnel where the fish can enter but not escape. Traps, like trawls, can potentially damage the bottom community, depending on where they are placed. If they are deployed and retrieved from coral habitats or live bottoms, they can damage the corals and other attached invertebrates on the reef. Seagrasses can also be broken or killed by the placement and retrieval of traps (GMFMC, 1998). Traps must be returned to shore at the end of every trip.

Competition between large numbers of commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as weather, hypoxia, and red or brown tides, may reduce fish resource standing populations. The impact of overfishing on fish resources can cause a measurable decrease in populations. Fishing techniques such as trawling or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. Hypoxia and red or brown tides may impact fish resources and EFH by suffocating or poisoning offshore populations of finfish and shellfish and live-bottom reef communities. Management practices for many fisheries stocks have resulted in a number of successes in recent years. It is expected that overfishing of some targeted species and trawl fishery bycatch would adversely affect fish resources. At the estimated level of effect, if overfishing were to occur, the resultant influence on fish resources would be expected to be substantial and easily distinguished from effects due to natural population variations.

Structure Removals

Structure removals would result in artificial habitat loss. It is estimated that 1,072-1,148 structures would be removed as a result of the OCS Program in the WPA and 4,925-4,949 structures would be removed in the CPA from 2007-2046. During the same timeframe, 830-922 structures would be installed as a result of the OCS Program in the WPA and 2,128-2,340 structures would be installed in the CPA. It is expected that structure removals would have a major effect on fish resources near the removal sites when explosives are used. However, only those fish proximate to sites removed by explosives would be killed; these expected impacts to fish resources have been shown to be small overall and would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000).

Spills

In the following analysis, the estimates of impacts to fish resources from petroleum spills comes from examinations of recent spills such as the North Cape, Breton Point, Sea Empress, and Exxon Valdez (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of petroleum spilled by each event and its estimated impact to fish resources were used as a guideline to estimate the impacts to fisheries in this EIS.

Spills that contact coastal bays, estuaries, and offshore waters when pelagic eggs and larvae are present have the greatest potential to affect fish resources. If spills were to occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For eggs and larvae contacted by spilled diesel, the effect is expected to be lethal.

It is estimated that 400-650 coastal spills <1,000 bbl would occur along the northern Gulf Coast annually (**Table 4-13**). About 92 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 6 bbl therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. It is expected that small coastal oil spills from non-OCS sources would affect coastal bays and marshes essential to the well-being of the fish resources and EFH.

It is estimated that one coastal spill ≥1,000 bbl from all sources would occur annually along the northern GOM (**Table 4-13**). About 75 percent of these spills are expected to be non-OCS-related activity (**Table 4-13**). One large coastal spill is projected to originate from OCS-related activity every 6 years. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would affect coastal bays and marshes essential to the well-being of the fishery resources and EFH in the cumulative proposed lease sale area.

One large (≥1,000 bbl) offshore spill is projected to occur annually from all sources Gulfwide. Of these offshore spills, one is estimated to occur every year from the Gulfwide OCS Program (**Table 4-13**). A total of 1,500 to 1,800 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. Of these 450-500 would originate from OCS program sources. **Chapter 4.3.11** describes projections of future spill events in more detail. The OCS-related spills in the cumulative area are expected to cause a 1 percent or less decrease in fish resources. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in fish resources.

Sediment Resuspension, Muds, and Cuttings

Subsurface blowouts of both oil and natural gas wells have the potential to adversely affect commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the GOM OCS (6 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS program from 2007 to 2046, it is projected that there would be 63-75 blowouts for all water depths in the WPA, and 169-197 blowouts in the CPA. Sandy sediments would be redeposited quickly within 400 m (1,312 ft) of a blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters (yards) over a period of 30 days or longer. These events are expected to have a negligible impact on fish populations.

Sediment would be resuspended during the installation of pipelines. Sandy sediments would be quickly redeposited within 400 m (1,312 ft) of the trench, and finer sediments would be widely dispersed and redeposited over a period of hours to days within a few thousand meters (yards) of the trench. Resuspension of vast amounts of sediments due to hurricanes also occurs on a regular basis in the northern GOM (Stone et al., 1996). It is expected that the infrequent subsurface blowout that may occur on the GOM OCS would have a negligible effect on offshore fish resources. The effect on fish resources from pipeline trenching is expected to cause a 5 percent or less decrease in standing stocks. Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m (3,281 ft) of the discharge point and would have a negligible effect on fisheries. Biomagnification of mercury in large fish high in the food chain is a problem in the GOM but the bioavailability and any association with trace concentrations of mercury in discharged drilling mud has not been demonstrated. Numerous studies have concluded that platforms do not contribute to higher mercury levels in marine organisms.

Produced Water

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Limited petroleum and metal contamination of sediments and the upper water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m (3,281 ft) of the discharge point, and have a negligible effect on fisheries. Offshore live bottoms would not be impacted. Offshore discharges and subsequent changes to marine water quality would be regulated by a USEPA NPDES permits.

Hurricanes

Hurricanes may impact fish resources by destroying both coastal wetlands and offshore live-bottom and reef communities and by changing physical characteristics of inshore and offshore ecosystems. As a cumulative impacting factor, hurricanes certainly had a substantial impact on Gulf Coast fisheries and EFH in 2005. Contrary to initial fears, however, the majority of significant fishery resource impacts were to nearshore costal and wetlands areas of Texas, Louisiana, Mississippi, and Alabama. Hurricanes Katrina and Rita did cause substantial infrastructure (artificial reef EFH) destruction offshore, but the actual impacts to fish resources and EFH were not significant. Even if the destroyed platforms were thought of as completely missing, the total number of destroyed platforms from both storms was 113 (**Chapter 3.3.5.7.3**, Damage to Offshore Infrastructure from Recent Hurricanes), a similar number to the total number of structures decommissioned in a single year. Much of the material from the destroyed platforms remains in various conditions as functional fish habitat. Much of this debris will eventually be removed, but the habitat loss will be spread out over time.

Hurricane Katrina's coastal winds exceeded 100 mph between the eastern side of Terrebonne Bay, Louisiana, and Biloxi, Mississippi (USDOC, NOAA, 2006c). Oil spills caused by Hurricane Katrina sent more than 8 million gallons of crude into southeast Louisiana bayous and rivers, according to the U.S. Coast Guard; 224 billion gallons of floodwaters were pumped out of New Orleans following Hurricanes Katrina and Rita. The most extensive loss to fisheries and EFH was to shallow-water habitats. Significant areas of fish nursery grounds were lost due to physical disturbance of marsh edge habitat and general wave destruction. Total wetlands loss has been conservatively estimated to be over 100 mi^2 in eastern Louisiana alone as a result of these storms. The USGS (USDOI, GS, 2005c) reported estimates that the effects of Hurricane Katrina transformed more than 30 mi^2 of marsh around the upper portion of Breton Sound to open water, or 20-26 percent of this 133-mi^2 area. Results of fisheries surveys conducted by NOAA in November 2005 indicate that offshore shrimp and bottom fish abundance was the same or higher than in the fall of 2004, with shrimp and other valuable species relatively abundant and widely distributed (USDOC, NOAA, 2005a). The surveys show some species, such as the commercially valuable and overfished red snapper, had a higher population in 2005 than in 2004. They also found that the Atlantic croaker population doubled in 2005. Collected samples were tested for toxins that might have been released into the marine ecosystem after hurricane flooding, such as PCB's, pesticides, and fire retardants. All samples show the levels of these compounds are well below Federal guidelines for safe seafood consumption. The samples also were tested for potential bacteria such as *E. coli*, which is associated with human fecal contamination. None of the samples harbored the bacteria, although other vibrio bacteria that normally inhabit the marine environment were found.

Studies conducted in Barataria Bay, Louisiana, post-Katrina/Rita also indicated shrimp and fish abundance at near normal levels and water temperatures and salinities near normal. Thus, it appears that shrimp and finfish resources of the northern Gulf fared much better during and after the hurricanes than did the fishing infrastructure that uses them (Hogarth, 2005). The worst resource devastation has occurred for oyster populations. According to Mississippi Department of Marine Resources estimates, approximately 90 percent of Mississippi's oyster beds were damaged and disrupted by Hurricane Katrina (Hogarth, 2005). Through early 2006, 100 percent of Mississippi's oyster fleet was out of work because of Hurricane Katrina. Oyster populations were similarly affected in parts of Louisiana. The impact to commercial fishing infrastructure, in general, was devastating (**Chapter 4.5.11**).

LNG Facilities

One additional cumulative impacting factor has been recently introduced as a possible significant impact to fisheries and offshore habitats in the future. This factor is the possibility of multiple offshore facilities for the offloading and regasification of liquefied natural gas (LNG) and the potential use of Gulf sea water for the warming process to convert the cold LNG to gas (known as the "open loop" technique). Three possible impacts to fisheries have been raised for open loop systems: (1) the antifouling chemicals needed to inhibit fouling growth within the system; (2) cooling of surrounding Gulf water from released open loop seawater after utilized; and (3) entrainment of fish eggs and larva with expected 100 percent mortality. Only one LNG port facility (Gulf Gateway Energy Bridge) has been fully approved and operational at the time of this writing. This facility consists of a submerged turret, and the first delivery was made in March 2005. The port has not been active since August 2005 because of hurricane pipeline damage and economics issues in exporting countries limiting distribution of LNG to the U.S. (USDOT, MARAD, 2006).

Early consensus of EIS's for individual facilities concluded that there would be no significant impacts to fisheries even at the water entrainment volumes of approximately 145 million gallons per day (USDOT, Coast Guard, 2003). The EIS for the Port Pelican project off Louisiana (USDOT, Coast Guard, 2003) concluded: "Minor adverse impacts may occur from the impingement and entrainment of ichthyoplankton (fish eggs and larvae)."

The first two concerns did not appear to be substantial; biofouling chemicals would be evaporated or diluted to background levels within a few meters of outfalls, and cold-water temperature plumes would extend only 100 m (328 ft) (USDOT, Coast Guard, 2003). Various constituencies, including State governments and fishing organizations, became even more concerned with the increased number of applications for creating offshore LNG facilities; at present, 14 applications for LNG Deepwater Port Act applications have been filed (USDOT, MARAD, 2006). On May 5, 2006, Governor Kathleen Blanco vetoed a proposed facility offshore Louisiana (Main Pass Energy Hub) because of the unknown cumulative impacts of additional facilities using the open loop system. A few days after that action, the same company proposed using a closed loop system where water is warmed by burning of the natural gas product rather than using surrounding Gulf seawater. The Office of the Governor (2006) responded, "Today's announcement is a very positive development. I can assure the company we will do everything reasonable and appropriate to expedite our review of its amended application."

The true impacts of an open loop system have yet to be determined, primarily because of the lack of information regarding the seasonal and vertical stratification of fish eggs and larva in the water column in relationship to open loop water intakes. Future research and monitoring that will be performed by the previously licensed facilities will help determine the necessity of using the expensive (up to $40 million per year) alternative of closed loop systems. At this point in time, the cumulative impacts from future LNG facilities using an open loop system will not be a consideration because of the likely continued permitting freeze.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events in the northern GOM have the potential to cause detrimental effects on fish resources and EFH. Impact-producing factors of the cumulative scenario that are expected to substantially affect fish resources and EFH include coastal and marine environmental degradation, overfishing, and to a lesser degree, coastal petroleum spills and coastal pipeline trenching. At the estimated level of cumulative impact, the resultant influence on fish resources and EFH is expected to be substantial, but not easily distinguished from effects due to natural population variations.

The incremental contribution of a proposed action's impacts on fish resources and EFH to the cumulative impact is small (as analyzed in **Chapter 4.2.1.1.8** for the WPA, **Chapter 4.2.2.1.10** for the CPA, and **Chapter 4.4.10** for accidental impacts**.**). The effects of impact-producing factors (coastal and marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to a proposed action are expected to be negligible (resulting in less than a 1% decrease in fish populations or EFH) and almost undetectable among the other cumulative impacts. Even with consideration of an extreme year of major hurricane impacts to coastal wetlands in 2005, the cumulative impact of the proposed action is expected to be negligible and undetectable.

The cumulative impact is expected to result in a less than 10 percent decrease in fish resource populations or EFH. It would require 2-3 generations for fishery resources to recover from 99 percent of the impacts. Recovery cannot take place from habitat loss (without unprecedented coastal reconstruction and wetlands restoration on an immense scale).

4.5.11. Impacts on Commercial Fishing

This cumulative analysis considers activities that could occur and adversely affect commercial fishing for the years 2007-2046. These activities include effects of the OCS Program (proposed action and prior and future OCS sales), State oil and gas activity, the status of commercial fishery stocks, oil transport by tankers, natural phenomena, and commercial and recreational fishing. Specific types of impact-producing factors considered in this cumulative analysis include commercial and recreational fishing techniques or practices, hurricanes, installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters.

Competition between large numbers of commercial fishermen, between commercial operations employing different fishing methods, and between commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as hurricanes, hypoxia, and red or brown tides, may impact commercial fishing activities. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. In addition, continued fishing of most commercial species at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. These effects will likely result in State and Federal constraints, such as closed seasons, excluded areas, quotas, size and weight limits on catch, and gear restrictions on commercial fishing activity. Significant progress has been made in recent years, removing managed species from *overfished* and *undergoing overfishing* lists (GMFMC, 2004a).

Space-use conflicts and conflicts over possession of the resources can result from different forms of commercial operations and between commercial and recreational fisheries. These effects will likely result in State and Federal constraints, such as quotas and/or gear restrictions, on commercial fishing activity. Finally, hurricanes may impact commercial fishing by damaging gear and shore facilities and dispersing resources over a wide geographic area (see section below). The availability and price of key supplies and services, such as fuel, can also affect commercial fishing. The impact from the various factors described above is expected to result in a 10 percent or less decrease in commercial fishing activity, landings, or value of landings.

A range of 830-922 structures is projected to be installed as a result of the OCS Program in the WPA, and 2,128-2,340 structures is projected to be installed in the CPA. Approximately 92-94 percent of these installations are in typical trawling water depths of 200 m (656 ft) or less. If all of the structures are major production structures, a maximum of 5,532, and 14,040 ha (34,694 ac, 6 ha (15 ac) per platform) would be eliminated from trawl fishing for up to 40 years from the WPA and CPA, respectively. A few major deepwater facilities would likely request the maximum 500-m (1,640-ft) navigational safety zone radius comprising a total area of 78 ha (193 ac) for each facility. These additional potential exclusion areas do not meaningfully change the previous totals because these larger safety zones do not prohibit vessels shorter than 100 ft from entering, and the numbers used above were also the maximum of estimated ranges. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms would continue to be less than 1 percent of the total area available to commercial trawl fishing. For example, the maximum number of 14,040 ha (34,694 ac) of area representing structures installed in the CPA represents only 0.052 percent of the total area of the Central Planning Area. It is expected that platform emplacement would infrequently affect trawling activity.

Structure removals result in artificial habitat loss and cause fish kills when explosives are used. It is estimated that 738-775 structures would be removed using explosives as a result of the OCS Program in the WPA and 3,487-3,495 structures would be removed in the CPA between 2007 and 2046. It is expected that structure removals will have a negligible effect on commercial fishing because the removals kill only those fish proximate to the removal sites. The expected impacts to fish resources from explosive removals have been shown to be small overall, and would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000).

If platforms are considered a positive factor for commercial fishing, i.e., artificial reefs are responsible in some manner for commercially important fish production and EFH, there could be a concern if most all platforms were removed from the Gulf. Using high-end estimates for installations and removals (**Tables 4-5 and 4-6**), there may be a net loss of standing production platforms at the end of the scenario period in 2046. Approximately 4,000 structures currently exist in the WPA and CPA. The total of artificial reef numbers (consisting of offshore platforms) is projected to be reduced from 4,000 to a range of 861-1265 after 39 years. The vast majority of this reduction would occur in water depths less than 200 m (656 ft). The overall effect on habitat is not very clear. It is presumed that the Rigs-to-Reefs program will continue and will increase the number of structures accepted into the program for deployment in artificial reef planning areas of all five Gulf Coast States (Appendix A.4). It has been demonstrated that toppled or relocated platform structures do not function as fish habitat as efficiently as a standing platforms; they are, nonetheless, extremely efficient as fish habitat in areas with only soft sediment bottom habitat (most all the Gulf of Mexico). To date, there have been approximately 250 platforms donated to the Rigs-to-Reefs program. If the number of rigs used in the Rigs-to-Reefs program increased to the majority of those being decommissioned (at least 70 per year), there would be no net loss of large artificial reefs represented by oil and gas structures in the WPA and CPA. An alternative view can also be taken. Prior to the 1950's, there were no oil and gas platforms in the GOM, and commercial species such as the red snapper existed in much higher numbers than they do today, particularly in the Eastern Gulf. An obvious conclusion is that, when platforms do not exist, fish use other natural habitats. However, with the present-day level of trawling and bycatch impacts, platforms may be providing protection that would also be eliminated with decommissioning.

Seismic surveys will occur in both shallow and deepwater areas of the Gulf of Mexico under the OCS Program. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the Gulf. Gulf of Mexico species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. The limited numbers of studies looking at the impact of seismic sound on fish have demonstrated very minor behavior impacts or have been flawed in design and inferred application to deep open water of the OCS (McCauley et al., 2003). Gear conflicts between seismic surveys and commercial fishing are also mitigated by the Fishermen's Contingency Fund. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners*, a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

The potential causes, sizes, and probabilities of petroleum spills that could occur during activities associated with the proposed actions are discussed in **Chapters 4.3.1**. Information on spill response and cleanup is contained in **Chapter 4.3.5**. In the following analysis, the estimations of impacts to fisheries from oil spills come from examinations of spills such as the *North Cape*, *Breton Point, Sea Empress*, and *Exxon Valdez* (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of oil spilled by each event and its estimated impact on fishing practices and fisheries economics was used as a guideline to estimate the impacts on commercial fishing under the OCS Program.

It is estimated that 400-650 coastal spills <1,000 bbl will occur along the northern Gulf Coast annually (**Table 4-13**). About 92 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 5 bbl; therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that small, coastal oil spills from non-OCS sources would often affect coastal bays and marshes. Commercial fishermen will actively avoid the area of a spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or value of catch for several months.

It is estimated that one coastal spill ≥1,000 bbl would occur annually along the northern Gulf (**Table 4-13**). About 75 percent of these spills are expected to be non-OCS related. Only one large coastal spill is projected to originate from OCS-related activity every 6 years. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would often affect coastal bays and marshes essential to the well-being of the commercial fishery resources in the cumulative activity area.

One large (≥1,000 bbl) offshore spill is estimated to occur annually from all sources Gulfwide. One offshore spill is estimated to occur every year from the Gulfwide OCS Program (**Table 4-13**).

A total of 1,550-2,150 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. The impact of OCS-related spills in the cumulative area is expected to cause a 1 percent or less decrease in commercial fishing. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in commercial fishing. At the expected level of impact, the resultant influence on commercial fishing, landings, or the value of those landings is expected to be considerable but not easily distinguished from effects due to natural population variations.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to adversely affect commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf OCS (6 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS program from 2007 to 2046, it is projected that there would be 63-75 blowouts in the WPA and 169-197 blowouts in the CPA. In addition, sediment would be resuspended during the installation of pipelines. Sandy sediments would be quickly redeposited within 400 m (1,312 ft) of the trench, and finer sediments would be widely dispersed and redeposited over a period of hours to days within a few thousand meters (yards) of the trench. These minor impacts are considered negligible in consideration of the proximity to the structures themselves, already prohibiting most commercial fishing practices in the vicinity. Resuspension of vast amounts of sediments due to large storms and hurricanes occurs on a regular basis in the northern Gulf of Mexico (Stone et al., 1996). It is expected that the infrequent subsurface blowout that may occur on the Gulf OCS would have a negligible effect on commercial fishing. The cumulative effect on commercial fisheries from pipeline trenching is expected to cause a 1 percent or less decrease in commercial fishing, landings, or value of those landings. At the estimated level of effect, the resultant influence on commercial fishing is not expected to be distinguished from effects due to natural population variations.

Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m (3,281 ft) of the discharge point and would have a negligible cumulative effect on fisheries.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m (3,281 ft) of the discharge point, and have a negligible cumulative effect on fisheries.

Future offshore LNG facilities are not projected to have any impact on commercial fishing at this time. Only two facilities have been licensed to use the "open loop" technique for regasification. Other recent LNG port applications have been rejected by State government, and the most recent will be switching to the "close loop" system with drastically reduced seawater entrainment and speculated fisheries losses (see also **Chapter 4.5.10**, Fish Resources and EFH).

Hurricanes

Commercial fisheries landings of the Central Gulf Coast were drastically impacted by Hurricanes Katrina and Rita in 2005 as a result of the severe impact on coastal port facilities and fishing vessels. This was clearly the most destructive impact to commercial fishing infrastructure in U.S. history, but there are also many indications that these levels of impacts could reoccur during the program analysis period of 2007-2046 (continued high peak in hurricane numbers and continuing increase in sea surface temperatures). There is no conclusive estimate of the number of fishing vessels sunk or driven ashore because of the 2005 storms, but the USCG initially estimated the number to be between 3,500 and 5,000. This estimate includes nearly 2,400 commercial vessels and 1,200 recreational boats (Hogarth, 2005). In Mississippi alone, almost 70 percent of all the commercial and recreational fishing industry assets in coastal Mississippi were damaged by Hurricane Katrina (Mississippi State University, 2006a). Comparing the same states (Western Florida, Mississippi, Alabama, Louisiana, and Texas), based on figures obtained for September 2005, there was a 97 percent reduction in shrimp landings and a 94 percent reduction in oyster landings, representing a combined loss of over $62 million for the month of September alone. Louisiana catches dropped off entirely for these species. Catches of a number of finfish species were essentially zero in September 2005, including menhaden, blue crab, spiny lobster, stone crab, yellowfin tuna, mullets, and freshwater crawfish. Reef fish catches declined by 44 percent regionwide. These reductions in commercial catches have persisted in most affected areas since September 2005 (Hogarth, 2005). Limited shrimp, crab, and other seafood processing has been reestablished initially in the central areas of Louisiana that received the least damage as reported in October 2005 (Bell, 2006). Other fishing, shrimping, crabbing, and harvesting of molluscan shellfish are anticipated to resume as the industry recovers in different areas from the hurricane damage.

The U.S. Department of Commerce has declared a "fishery failure and fishery resource disaster declaration" for the Gulf of Mexico. The Secretary of Commerce is consequently authorized to request Federal relief funds from the Congress and to make those funds available to the affected Gulf States to assess the impacts of the disaster, to restore fisheries, to prevent future failure, and to assist affected fishing communities' recovery after the disaster (Diop, 2006). Substantial funding for commercial fishing infrastructure rebuilding was added to Gulf Coast recovery legislation in June 2006.

As opposed to initial concerns about the contamination of sediments and fish and shrimp tissue resulting from pollution caused by the hurricanes, NOAA studies found no evidence of hydrocarbons, persistent organic pollutants, or bacterial contamination (Hogarth, 2005; USDOC, NOAA, 2005a). The survey results are consistent with similar findings announced by the FDA, USEPA, and the States of Mississippi, Louisiana, and Alabama, which concluded Gulf seafood was deemed safe for human consumption. As reported in a six-month progress update (U.S. Dept. of Homeland Security, 2006), NOAA is also involved in surveying the fisheries infrastructure including processing plants, ice plants, boat yards, piers, and supply stores. NOAA has also been directly involved in prioritizing vessel removals based on pollution and habitat threats for the thousands of vessels impacted.

Although the storm impacts of 2005 were substantial and could be repeated in coming years, the incremental contribution of the proposed actions to the cumulative impact is expected to be negligible. Natural disaster impacts are easily distinguished from incremental impacts of the OCS activities.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events have the potential to cause limited detrimental effects to commercial fishing, landings, and value of those landings. Impact-producing factors of the cumulative scenario that are expected to substantially affect commercial fishing include commercial and recreational fishing techniques or practices, hurricanes, installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Recent substantial impacts were because of the tropical storms of 2005. At the estimated level of cumulative impact, the resultant influence on commercial fishing, landings, and value of those landings is expected to be substantial and easily distinguished from effects due to natural population variations.

The incremental contribution of a proposed action's impacts to commercial fishing (as analyzed in **Chapter 4.2.1.1.9** for a WPA proposed action, **Chapter 4.2.2.1.11** for a CPA proposed action, and **Chapter 4.4.10** for accidental impacts) to the cumulative impact is small. The effects of impact-producing factors (installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, oil spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to a proposed action are expected to be negligible (less than a 1 percent decrease in commercial fishing, landings, or value of those landings) and almost undetectable among the other cumulative impacts. A notable long-term trend is the diminishing numbers of standing platforms considered obstructions.

The cumulative impact is expected to result in a less than 10 percent decrease in commercial fishing, landings, or value of those landings. It would require 3-5 years for fishing activity to recover from 99 percent of the impacts.

4.5.12. Impacts on Recreational Fishing

This cumulative analysis considers existing recreational and commercial fishing activity, artificial reef developments, fishery management regimes, and past and future oil and gas developments. As indicated in the other recreational fishing sections (**Chapters 4.2.1.1.10 and 4.2.2.1.12**), sport fishing is a very popular recreational activity throughout the GOM and is one of the major attractions that generate significant tourism economies along the Louisiana, Alabama, and Florida coastal areas. The latest information indicates participation in marine recreational fishing in the GOM has shown annual increases since 1997 (USDOC, NMFS, 1999c).

In many instances throughout the GOM, competition between commercial and recreational fishermen targeting the same species has led to depleted fish stocks and habitat alterations. Over 30 years ago, national concern for the health and sustainability of marine fisheries led to Federal legislation that has resulted in the development of fishery management plans affecting recreational fish species in the GOM.

Fisheries management plans focused on targeted species, such as red snapper, have led to size and creel limits as well as seasonal closures and gear restrictions or modifications in both commercial and recreational fishing. Recent amendments to the Magnuson Fishery Conservation and Management Act require that fishery management plans also identify essential fish habitat to allow it to be protected from fishing, other coastal and marine activities, and developments.

All Gulf States have aggressively supported artificial reef development programs to help encourage and increase interest and enjoyment in offshore recreational fishing. Alabama, for example, has permitted over 1,000 mi^2 (640,000 ac) of offshore area for artificial reef development and has cooperated with the military and other Federal agencies in acquiring materials such as tanks, ships, and oil and gas structures for reef development and enhancement. Although the structures associated with a proposed action would act as artificial reefs, recreational fishermen, due to the water depths of the proposed lease sale area, would target pelagic, highly migratory species such as tuna. Operators may request from the USCG that safety zones be implemented around these deepwater structures. Current USCG policy applies only to vessels greater than 100 ft in length; therefore, it does not apply to most recreational fishing vessels.

Almost all offshore recreational fishing is currently confined within 100 mi (161 km) of shore. Very few fishing trips go beyond the 200-m (656-ft) contour line. Approximately 3,866 oil and gas platforms are in Federal waters in 0-200 m (0-656 ft), and they have had a dramatic and long-term positive effect on offshore fish and fishing. The number of offshore platforms is estimated to decrease in the future (removals would outpace installations). Although it is known that fish abundance and species composition can change dramatically with platform size, location, and season of the year, Stanley (1996) has suggested that the average major platform can harbor over 20,000 fish. The fish range out in proximity to the structure and are concentrated throughout the water column, mainly in the top 200-ft of water. The fish become scarce at depths below 200 ft. Based on the NOAA Fisheries Service Statistics Survey, Witzig (1986) estimated that over 70 percent of all recreational fishing trips that originated in Louisiana and extended more than 3 mi from shore targeted oil and gas structures for recreational fishing.

Impact-producing factors associated with cumulative effects to recreational fisheries from routine OCS operations also include space-use conflicts. Conflicts are usually minimal as compared with some types of commercial fisheries. However, there is recreational shrimp trawling for wild shrimp, and trawls can become entangled with OCS structures in the water. Recreational rod and reel anglers often target oil and gas platforms because these structures act as FAD's.

Noise from rig and platform installation may scatter some groundfish away from their homing area. This may result in decreased recreational catch, but most fish will return once the noise quits. Platform removal using explosives may impact recreational fisheries by driving some fish away. Some fish will be killed and a structure that may be targeted as a fishing location by recreational anglers could be eliminated. Non-OCS activities could also have the potential to adversely affect recreational fisheries, with most impacts occurring in nearshore coastal waters. Recreational fisheries may be affected by coastal development, commercial fishing, dredge and fill activities, and marine mining.

Oil spills can affect recreational fishers in ways similar to those stated for commercial fishers – fouling gear with oil, tainting the catch, and degrading water quality and fishing grounds – all of which could occur as a result of either OCS or non-OCS cumulative activities. Recreational fishing boats inadvertently contacting spills or pollution caused by accidents associated with OCS or non-OCS could be soiled, which may require the fishermen to temporarily modify their fishing plans. Spills are unlikely to decrease recreational fishing activity but may divert the location or timing of a few planned fishing trips.

The OCS oil spills most likely to affect recreational anglers would be the shallow water spills since the recreational anglers are less likely to venture far offshore. Most recreational fishing is conducted close to shore. It is unlikely that all of these assumed spills will occur inshore. Therefore, the overall impact of these spills on recreational fisheries will be less than would be expected for the commercial fisheries.

In addition, public perception of the effects of a spill on marine life and its extent may ultimately result in a loss of revenue for the fishing-related recreation industry. Party and charter boat recreational fisheries often have loss of income because of reduced interest in fishing when a spill has occurred. Local hotel, restaurant, bait and tackle shops, and boat rental companies associated with recreational fisheries may experience reduced sales because of the public perception of the effects of an oil spill.

Summary and Conclusion

Recreational fishing continues to be a popular nearshore and offshore recreational activity in the northeastern and central GOM. Concern for the sustainability of fish resources and marine recreational fishing has led to Federal legislation that established a fisheries management process that will include the identification and protection of essential fish habitat. The incremental contribution of a proposed action (as analyzed in **Chapters 4.2.1.1.10 and 4.2.2.1.12**) to the cumulative impact on recreational fishing is positive, although minor due to the relatively small number of structures projected for the next 40 years. The cumulative impact of OCS and State oil and gas activities and import tanker spills would be minor. Implementation of a proposed action would attract some private and charter-boat recreational fishermen farther offshore to the vicinity of the developed lease tracts in pursuit of targeted species known to be associated with petroleum structures in deep water.

4.5.13. Impacts on Recreational Resources

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions (**Chapters 4.2.1.1.11 and 4.2.2.1.13**), plus those related to prior and future OCS sales, State offshore and coastal oil and gas activities throughout the GOM, tankering of crude oil imports, merchant shipping, commercial and recreational fishing, military operations, recreational use of beaches, and other offshore and coastal activities that result in debris, litter, trash, and pollution, which may adversely affect major recreational beaches. Specific OCS-related impact-producing factors analyzed include trash and debris, the physical presence of platforms and drilling rigs, support vessels and helicopters, oil spills, and spill clean-up activities. Other factors such as land development, civil works projects, and natural phenomena have affected, and will continue to affect, the quality of the beach environment and public use and appreciation of major recreational beaches. Ultimately, all these factors plus the health of the U.S. economy and the price of gasoline can affect the travel and tourism industry and the level of beach use along the U.S. Gulf Coast.

Trash and debris are a recognized problem affecting enjoyment and maintenance of recreational beaches along the Gulf Coast. From extensive aerial surveys conducted by NOAA Fisheries Service over large areas of the GOM, floating offshore trash and debris was characterized by Lecke-Mitchell and Mullin (1997) as a ubiquitous, Gulfwide problem. Coastal and offshore oil and gas operations contribute to trash and debris washing up on Texas and Louisiana beaches (Miller and Echols, 1996; Lindstedt and Holmes, 1988). **Chapter 4.1.2.2.4** discusses recent beach cleanups conducted in Texas, Louisiana, Mississippi, Alabama, and Texas; and indicates volunteers removed about 700,000 of pounds of trash and debris from coastal recreational beaches. Regulatory, administrative, educational, and volunteer programs involving government, industry, environmental, school, and civic groups; specific marine user groups; and private citizens are committed to monitoring and reducing the beach litter problem Gulfwide.

Continued and expanded oil and gas operations throughout the GOM have contributed to the trash and debris on coastal beaches. Trash and debris detract from the aesthetic quality of beaches, can be hazardous to beach users, and can increase the cost of maintenance programs. Other offshore activities (such as merchant shipping; Naval operations; offshore and coastal commercial and recreational fishing, State offshore oil and gas activities), coastal activities (such as recreation; State onshore oil and gas activities; condominiums and hotels), and natural phenomena (such as storms, hurricanes, and river outflows) contribute to debris and pollution existing on the major GOM recreational beaches.

The OCS oil and gas industry has improved offshore waste management practices and evidenced a strong commitment to participate in the annual removal of trash and litter from recreational beaches affected by their offshore operations. Furthermore, MARPOL Annex V and the special efforts to generate cooperation and support from all Gulf user groups through the GOM Program should lead to a decline in the overall level of human-generated trash adversely affecting recreational beaches throughout the Gulf.

At present, there are approximately 4,000 OCS platforms on the GOM OCS. The WPA is 10 mi from Texas; therefore, no structures located in the WPA would be visible from shore. The CPA is located 3 nmi from Louisiana, Mississippi, and Alabama. In the CPA, there are nearly 1,000 platforms (34% of structures in less than 60 m (197 ft)) within 10 mi of the coast. Of those, most (84%) are located in the CPA west of the Mississippi River. In the CPA east of the Mississippi River, 14 percent of OCS platforms are within 10 mi of the Louisiana, Mississippi, or Alabama coast. Based on these numbers and peak-year projections, a maximum of about 1,000 OCS production structures will be visible from shore at one time and this number will drastically decrease during the 40-year analysis period as operations move into deeper water. Oil and gas operations in State waters off Texas, Louisiana, and Alabama are also visible form shore. Aesthetic impacts of the visible presence of offshore drilling rigs and platforms are unlikely to affect the level of beach recreation, but they may affect the experience of some beach users, especially at beach areas such as the Padre Islands National Seashore in Texas and the Gulf Islands National Seashore on Mississippi's outer barrier islands.

Vessels and helicopter traffic servicing OCS operations will be seen and heard by beach users from time to time. Existing and future oil and gas developments in the State waters contribute to these impacts. Commercial and recreational maritime traffic add to the visual and noise impacts.

The primary impact-producing factors associated with offshore oil and gas exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills and offshore trash, debris, and tar (see **Chapter 4.4.12** for a discussion of the potential impacts of oil spills on recreational beaches). All of the respondents from a total of 39 semi-structured discussions conducted from March through May 1997 for the MMS study, "Socioeconomic and Environmental Issues Analysis of Oil and Gas Activity on the Outer Continental Shelf of the Western Gulf of Mexico," recognized environmental threats posed by the nature and specific operations of the industry (Kelley, 2002). Most respondents to the study believed that a major oil spill would have devastating effects on the tourist industry. While "small" spills were deemed to occur with some frequency, it is "the big one" that people most fear. Offshore trash and tar is often noted as the second biggest threat to the conditions of the beaches in the GOM coastal region. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation. Soil contamination and air and water pollution created by the refining of oil and the production of petrochemical products are other areas of concern.

Chapter 4.3.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios analyzed hypothetical oil spills of ≥1,000 bbl occurring from future OCS oil and gas operations in the GOM. Should such a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks, or until the cleanup operations were complete. Should a spill occur, factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods would have a bearing on the severity of effects the spill would have on a recreational beach and its use. Sorenson (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded that a spill near a coastal recreation area would reduce visitation in the area by 5-15 percent over one season but would have no long-term effect on tourism.

The estimated annual oil spill occurrences expected in the future in the WPA or CPA, based on historical data maintained by MMS and USCG, are presented in **Table 4-13**. The great majority of coastal spills that do occur from OCS-related activities are likely to originate near terminal locations in the coastal zone around marinas, refineries, commercial ports, pipeline routes, and marine terminal areas, usually during the transfer of fuel. The average fuel-oil spill is 18 bbl. It is expected that these frequent, but small, spills will not affect coastal beach use.

Although hundreds of small spills are documented annually from all sources within the marine and coastal environment of the Gulf Coast, it is primarily large spills (≥1,000 bbl) that are a major threat to coastal beaches. Should a large spill impact major recreational beaches, no matter the source, it will result in unit and park closures until cleanup is complete. Oil-pollution events impacting recreational beaches will generate immediate cleanup response from responsible oil and gas industry sources. Recreational use will be displaced from impacted beaches and closed parks (generally 2-4 weeks). Recreational use and tourism impacts will be more significant if spills affect beaches during peak-use seasons and if publicity is intensive and far-reaching.

Summary and Conclusion

Debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and to degrade the ambience of shoreline recreational activities, thereby affecting the enjoyment of recreational beaches throughout the area. The incremental beach trash resulting from the proposed actions is expected to be minimal.

Platforms and drilling rigs operating nearshore may affect the ambience of recreational beaches, especially beach wilderness areas. The sound, sight, and wakes of OCS-related and non-OCS-related vessels, as well as OCS helicopter and other light aircraft traffic, are occasional distractions that are noticed by some beach users.

Oil that contacts the coast may preclude short-term recreational use of one or more Gulf Coast beaches at the park or community levels. Displacement of recreational use from impacted areas will occur, and a short-term decline in tourism may result. Beach use at the regional level is unlikely to change from normal patterns; however, closure of specific beaches or parks directly impacted by a large oil spill is likely during cleanup operations. The incremental contribution of a proposed action (as analyzed in **Chapters 4.2.1.1.11 and 4.2.2.1.13**) to the cumulative impact on recreational resources is minor due to the limited effect of increased helicopter, vessel traffic, and marine debris on the number of beach users. The cumulative impact of OCS and State oil and gas activities would be minor.

4.5.14. Impacts on Archaeological Resources

The following cumulative analysis considers the effects of the impact-producing factors related to a proposed action, OCS activities in the cumulative activity area, trawling, sport diving, commercial treasure hunting, seismic exploration in State waters, and tropical storms on archaeological resources. Specific types of impact-producing factors associated with OCS activities that are considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, anchoring, oil spills, dredging, new onshore facilities, and ferromagnetic debris.

4.5.14.1. Historic

Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a historic resource. The surveys are expected to be most effective in areas where there is only a thin veneer of unconsolidated Holocene sediments. In these areas shipwreck remains are more likely to be exposed at the seafloor where they can be detected by the side-scan sonar as well as the magnetometer. In areas of thicker unconsolidated sediments, shipwreck remains are more likely to be completely buried with detection relying solely on magnetometer. According to estimates presented in **Table 4-4**, an estimated 38,677-45,338 exploration, delineation, and development wells will be drilled, and 2,958-3,262 production platforms will be installed as a result of the OCS Program. Of this range, between 19,840 and 22,216 exploration, delineation, and development wells will be drilled, and 2,779-2,991 production structures will be installed in water depths of 200 m (656 ft) or less. The majority of lease blocks in this water depth have a high potential for historic shipwrecks. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that any major impacts to historic resources that may have occurred resulted from development prior to this time.

Of the 17,785 lease blocks in the OCS Program area, less than half of these blocks are leased. There are 3,726 blocks that fall within the Gulf of Mexico Region's high-potential areas for historic resources. Of these blocks, 2,095 blocks are in water depths of 200 m (656 ft) or less and will require a survey at 50-m linespacing. The potential of an interaction between rig or platform emplacement and a historic shipwreck is greatly diminished by requisite site surveys, but still exists. Such an interaction could result in the loss of or damage to significant or unique historic resources.

Table 4-4 indicates the placement of between 9,470 and 66,550 km (5,884-41,352 mi) of pipelines is projected in the cumulative activity area. While the required archaeological survey minimizes the chances of impacting a historic shipwreck, there remains a possibility that a wreck could be impacted by pipeline emplacement. Such an interaction could result in the loss of significant or unique historic resources.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact historic wrecks. Archaeological surveys serve to minimize the chance of impacting historic wrecks; however, these surveys are not infallible and the chance of an impact from future activities does exist. Impacts from anchoring on a historic shipwreck may have occurred. There is also a potential for future impacts from anchoring on a historic shipwreck. Such an interaction could result in the loss of or damage to significant or unique historic resources and the scientific information they contain.

The probabilities of offshore oil spills ≥1,000 bbl occurring from OCS Program activities is presented in **Chapter 4.3.1**. Oil spills have the potential to impact coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. The impacts caused by oil spills to coastal historic archaeological resources are generally short term and reversible. **Table 4-14** presents the coastal spill scenario from both OCS and non-OCS sources. It is assumed that the majority of the spills will occur around terminals and be contained in the vicinity of the spill. Should such oil spills contact a historic site, the effects would be temporary and reversible.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high potential for historic shipwrecks; the greatest concentrations of historic wrecks are likely associated with these features (Pearson et al., 2003). It is reasonable to assume that significant or unique historic archaeological information has been lost as a result of past channel dredging activity. In many areas, the COE requires remote-sensing surveys prior to dredging activities to minimize such impacts.

Past, present, and future OCS oil and gas exploration and development and commercial trawling will result in the deposition of tons of ferromagnetic debris on the seafloor. Modern marine debris associated with these activities will tend to mask the magnetic signatures of historic shipwrecks, particularly in areas that were developed prior to requiring archaeological surveys. Such masking of the signatures characteristic of historic shipwrecks may have resulted or may yet result in OCS activities in the cumulative activity area impacting a shipwreck containing significant or unique historic information.

Trawling activity specifically would only affect the uppermost portions of the sediment column (Garrison et al., 1989). On many wrecks, the uppermost portions would already be disturbed by natural factors and would contain only artifacts that have lost all original context.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the National Historic Preservation Act (NHPA) are not under the jurisdiction of MMS in those areas. However, other Federal agencies, such as the COE, which issues permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by OCS-related pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. Efforts to educate sport divers and to foster the protection of historic shipwrecks, such as, those of the Texas Historical Commission and the Southwest Underwater Archaeological Society (Arnold, personal communication, 1997), will serve to lessen these potential impacts. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. Since the extent of these activities is unknown, the impact cannot be quantified. A Spanish war vessel, *El Cazador*, was discovered in the Central Gulf of Mexico, which contained a large amount of silver coins and has been impacted by treasure hunting salvage operations (*The Times Picayune*, 1993). The historic data available from this wreck and from other wrecks that have been impacted by treasure hunters and sport divers represent a significant or unique loss.

Tropical storms and hurricanes are normal occurrences in the GOM and along the Gulf Coast. On average, 15 to 20 hurricanes make landfall along the northern Gulf Coast per decade. Shipwrecks in shallow waters are exposed to a greatly intensified, longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts (e.g., ceramics and glass) would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information would also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms. Some of the data lost have most likely been significant or unique.

Summary and Conclusion

Several impact-producing factors may threaten historic archaeological resources. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a historic shipwreck located on the continental shelf. The archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease area are expected to be highly effective at identifying possible historic shipwrecks. The OCS development prior to requiring archaeological surveys has possibly impacted wrecks containing significant or unique historic information.

The loss or discard of ferromagnetic debris associated with oil and gas exploration and development and trawling activities could result in the masking of historic shipwrecks.

Loss of significant or unique historic archaeological information from commercial fisheries (trawling) is not expected. It is expected that dredging, sport diving, commercial treasure hunting, and tropical storms have impacted and will continue to impact historic period shipwrecks. Additionally, it is possible that explosive seismic surveys on the OCS and within State waters, prior to 1989, could have impacted historic shipwrecks. Explosive seismic charges set near historic shipwrecks could have displaced the vessel's surrounding sediments acting like a small underwater fault and moving fragile wooden, ceramic and metal remains out of their initial cultural context. Such an impact would have resulted in the loss of significant or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact between a historic site and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts. The expected effects of oil spills on historic coastal resources are temporary and reversible.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique historic archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed actions is expected to be very small due to the efficacy of the required remote-sensing survey and archaeological report. However, there is a possibility of an interaction between bottom-disturbing activity (rig emplacement, pipeline trenching, and anchoring) and a historic shipwreck.

4.5.14.2. Prehistoric

Future OCS exploration and development activities in the Gulf of Mexico between 2007 and 2046 referenced in **Table 4-4** projects drilling 12,966-14,187 exploration, delineation, and development wells in water depths <60 m (197 ft). Relative sea-level curves for the Gulf of Mexico indicate there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m (197 ft). Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a prehistoric resource. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that the major impacts to prehistoric resources that may have occurred resulted from development prior to this time. The potential of an interaction between rig or platform emplacement and a prehistoric site is diminished by the survey, but still exists. Such an interaction would result in the loss of or damage to significant or unique prehistoric information.

The placement of 2,980-22,110 km (1,852-13,739 mi) and 2,340-9,580 km (1,454-5,953 mi) of pipelines in water depths <60 m (197 ft) is projected as a result OCS Program activities in the CPA and WPA, respectively. For the OCS Program, 5,320-31,690 km (5,320-19,691 mi) of pipelines are projected in water depths <60 m (197 ft). While the archaeological survey minimizes the chances of impacting a prehistoric site, there remains a possibility that a site could be impacted by pipeline emplacement. Such an interaction would result in the loss of significant or unique archaeological information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service vessel trips to the OCS have the potential to impact shallowly buried prehistoric sites. Archaeological surveys minimize the chance of impacting these sites; however, these surveys are not seen as infallible and the chance of an impact from future activities exists. Impacts from anchoring on a prehistoric site may have occurred. Such an interaction could result in the loss of significant or unique archaeological information.

The probabilities of offshore oil spills ≥1,000 bbl occurring from the OCS Program in the cumulative activity area is presented in **Chapter 4.3.1**. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. Coastal, oil-spill scenario numbers are presented in **Table 4-13** for both OCS and non-OCS sources. It is assumed that the majority of the spills will occur around terminals and will be contained in the vicinity of the spill. There is a small possibility of these spills contacting a prehistoric site. The impacts caused by oil spills to coastal prehistoric archaeological resources can severely distort information relating to the age of the site. Contamination of the organic site materials by hydrocarbons can make radiocarbon dating of the site more difficult or even impossible. This loss might be ameliorated by using artifact seriation or other relative dating techniques. Coastal prehistoric sites might also suffer direct impact from oil spill cleanup operations as well as looting resulting from interactions between persons involved in cleanup operations and unrecorded prehistoric sites. Interaction between oil-spill cleanup equipment or personnel and a site could destroy fragile artifacts or disturb site context, possibly resulting in the loss of information on the prehistory of North America and the Gulf Coast region. Some coastal sites may contain significant or unique information.

Most channel dredging occurs at the entrances to bays, harbors, and ports. Bay and river margins have a high potential for the occurrence and preservation of prehistoric sites. Prior channel dredging has disturbed buried and/or inundated prehistoric archaeological sites in the coastal plain of the Gulf of Mexico. It is assumed that some of the sites or site information were unique or significant. In many areas, the COE requires surveys prior to dredging activities to minimize such impacts.

Trawling activity would only affect the uppermost portion of the sediment column (Garrison et al., 1989). This zone would already be disturbed by natural factors, and site context to this depth would presumably be disturbed. Therefore, no effect of trawling on prehistoric sites is assumed. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Table 4-9 indicates the projected coastal infrastructure related to OCS Program activities in the cumulative activity area. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within MMS's jurisdiction. However, other Federal agencies, such as the COE, which lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by pipeline construction within State waters should be mitigated under the requirements of the NHPA.

About half of the coast along the northern Gulf was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). Prehistoric sites in shallow waters and on coastal beaches are exposed to the destructive effects of wave action and scouring currents. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed. Some of the original information contained in the site would be lost in this process. Overall, a significant loss of data from prehistoric sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms.

Summary and Conclusion

Several impact-producing factors may threaten prehistoric archaeological resources of the Gulf of Mexico. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric archaeological site located on the continental shelf. The required archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are expected to be highly effective at identifying possible prehistoric sites. OCS development prior to requiring archaeological surveys has possibly impacted sites containing significant or unique prehistoric information.

Should an oil spill occur and contact a coastal prehistoric site, loss of significant or unique information could result. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations.

The initial dredging of ports and navigation channels and tropical storms are assumed to have caused the loss of significant archaeological information.

Onshore development as a result of the OCS Program could result in the direct physical contact between a prehistoric site and new facility construction and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts.

The shallow depth of sediment disturbance caused by commercial fisheries activities (trawling) is not expected to exceed that portion of the sediments that have been disturbed by wave-generated forces.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique prehistoric archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed actions is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

4.5.15. Impacts on Human Resources and Land Use

4.5.15.1. Land Use and Coastal Infrastructure

The cumulative analysis considers the effects of impact-producing factors from OCS and State oil and gas activities. The OCS-related factors consist of prior, current, and future OCS lease sales. Unexpected events that may influence oil and gas activity within the analysis area, but cannot be predicted, are not considered in this analysis.

Chapters 3.3.5.1.2 and 3.3.5.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. The vast majority of this infrastructure also supports oil and gas production in State waters and onshore. As stated in **Chapter 4.1.3.1.1**, Leasing and Production, State oil and gas production is expected to continue to decline over the analysis period.

Land use in the analysis area will evolve over time. While the majority of this change is estimated as general regional growth rather than activities associated with the OCS Program and State production. Except for the projected 14 new gas processing plants and the 4-6 pipeline shore facilities, the OCS Program will require no new oil and gas coastal infrastructure. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle development. There is also sufficient land to construct the projected new gas processing plants and pipeline shore facilities in the analysis area. New facilities and expansions would also support State oil and gas production. Thus, the results of OCS and State oil and gas activities are expected to minimally alter the current land use of the area.

Shore-based OCS and State servicing should also increase in the ports of Galveston, Texas; Port Fourchon, Louisiana; and the Mobile, Alabama. There is sufficient land designated in commercial and industrial parks and adjacent to the Galveston and Mobile area ports to minimize disruption to current residential and business use patterns. Port Fourchon, though, has limited land available; operators have had to create land on adjacent wetland areas. Any changes in the infrastructure at Port Fourchon that lead to increases in Louisiana Highway 1 (LA Hwy 1) usage, will contribute to the increasing deterioration of the highway. In the absence of the planned expansions, LA Hwy 1 would not be able to handle future OCS and State activities. In addition, any changes that increase OCS and State demand of water will further strain Lafourche Parish's water system. Other ports in the analysis area that have sufficient available land plan to make infrastructure changes.

Since the State of Florida and many of its residents reject any mineral extraction activities off their coastline, oil and gas businesses are not expected to be located there.

Summary and Conclusion

Activities relating to the OCS Program and State production are expected to affect minimally the analysis area's land use. Most subareas in the analysis area have strong industrial bases and designated industrial parks to accommodate future growth in oil and gas businesses. Any changes (mostly expansions, except for the 14 projected new gas processing plants and the 4-6 new pipeline shore facilities) are expected to be contained on available land. Port Fourchon is expected to experience significant impacts to its land use from OCS-related expansion. Increased OCS-related usage from port clients is expected to significantly impact LA Hwy 1 in Lafourche Parish. Also, increased demand of water by the OCS will further strain Lafourche Parish's water system.

The incremental contribution of a proposed action to the cumulative impacts on land use and coastal infrastructure are expected to be minor. Of the new coastal infrastructure projected as a result of the OCS Program, only 0-1 new gas processing plants are expected to be constructed as a result of a WPA or CPA proposed action. Except for the 0-1 new pipeline landfalls projected, no new coastal infrastructure is projected as a result of WPA Lease Sale 200 (USDOI, MMS, 2002a). The proposed actions and WPA Lease Sale 200 would contribute to a small percentage of the projected OCS-related activity at Port Fourchon.

4.5.15.2. Demographics

The following cumulative analysis considers the effects of OCS-related, impact-producing as well as non-OCS-related factors. The OCS-related factors consist of population and employment from prior, current, and future OCS lease sales; non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity in State waters, and offshore LNG activity. Unexpected events that may influence oil and gas activity within the analysis area, but cannot be predicted, are not considered in this analysis.

Most approaches to analyzing cumulative effects begin by assembling a list of "other likely projects and actions" that will be included with the proposed action for analysis. However, no such list of future projects and actions could be assembled that would be sufficiently current and comprehensive to support a cumulative analysis for all 132 of the coastal counties and parishes in the analysis area (from Texas to Florida) over a 40-year period. Instead of an arbitrary assemblage of future possible projects and actions, this analysis employs the economic and demographic projections from Woods and Poole Economics, Inc. (2006) to define the contributions of other likely projects, actions, and trends to the cumulative case. These projections are based on local, regional, and national trend data as well as likely changes to local, regional, and national economic and demographic conditions. Therefore, the projections include population associated with the continuation of current patterns in OCS leasing activity as well as the continuation of trends in other industries important to the region. These Woods and Poole projections represent a more comprehensive and accurate appraisal of cumulative conditions than could be generated using the traditional list of possible projects actions. These projections also include Woods and Poole's assumptions regarding Hurricanes Katrina and Rita's impact on the Southeast (**Chapter 3.3.5.5**). Hence, the regional economic impact assessment methodology used to estimate changes to population for a proposed lease sale was used for the cumulative analysis.

This section projects how and where future demographic changes will occur and whether they correlate with the OCS Program. The addition of any new human activity, such as oil and gas development resulting from the proposed actions, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money that can translate into changes in the local social and economic institutions and land use.

Population

C**hapter 3.3.5.4.1** discusses the analysis area's baseline population and projections through 2030. The population of the eight parishes and counties that were most negatively impacted by Hurricanes Katrina and Rita (St. Bernard, Orleans, Plaquemines, Jefferson, Cameron, Louisiana; and Hancock, Jackson, and Harrison, Mississippi) are not expected to return to their pre-hurricane levels for several years. Population impacts from the OCS Program (**Tables 4-43 and 4-44)** mirror those assumptions associated with employment described below in **Chapter 4.5.15.3**. Projected population changes reflect the number of people dependent on income from oil and gas-related employment for their livelihood (e.g., family members of oil and gas workers). This figure is based on the ratio of population to employment in the analysis area over the 40-year analysis period. The population projections due to the OCS Program are calculated by multiplying the employment projections (**Chapter 4.5.15.3** Economic Factors, and **Tables 4-45 and 4-46**) by a ratio of the baseline population (**Table 3-35**) to the baseline employment (**Table 3-41**). Activities associated with the OCS Program are projected to have minimal effects on population in most of the coastal Subareas. Regions in Louisiana coastal subareas, Lafourche (EIA LA-3) and Lafayette (EIA LA-2) Parishes in particular, are expected to experience noteworthy increases in population resulting from increases in demand for OCS labor. **Chapter 4.5.15.3** below discusses this issue in more detail.

Following Hurricanes Katrina and Rita, some parishes and counties experienced population and employment gains because of residential displacement. In the updated Woods and Poole 2006 projections, St. Tammany Parish, Louisiana, was assumed to gain 27 percent; St. John the Baptist Parish, Louisiana, 21 percent; St. James Parish, Louisiana, 14 percent; Ascension Parish, Louisiana, 10 percent; East Baton Rouge Parish, Louisiana, 10 percent; Stone County, Mississippi. 15 percent; St. Charles

Parish, Louisiana, 18 percent; and Tangipahoa Parish, Louisiana, 18 percent from 2005 to 2006. Additional OCS-related employment and population could strain existing infrastructure and services in these communities. The population and employment increases are projected to stabilize in 2007.

Age

The age distribution of the analysis area is expected to remain virtually unchanged with respect to OCS Program activities. Given both the low levels of population growth and industrial expansion associated with the OCS Program, the age distribution pattern discussed in **Chapter 3.3.3.4.2** is expected to continue throughout the 40-year analysis period.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged with respect to the OCS Program. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in **Chapter 3.3.5.4.3** is expected to continue throughout the 40-year analysis period. (See **Chapters 3.3.5.4.1 and 3.3.5.4.3** for a discussion of race and ethnic composition changes in the New Orleans metropolitan area as a result of Hurricane Katrina.)

Summary and Conclusion

Activities relating to the OCS Program are expected to affect minimally the analysis area's demography. Baseline patterns and distributions of these factors, as described in **Chapter 3.3.5.4.1**, are not expected to change for the analysis area as a whole. The baseline population patterns are expected to change for the eight counties and parishes that were most negatively affected by the 2005 hurricane season (see **Chapter 3.3.5.4** for a discussion of these changes). Some regions within Louisiana coastal Subareas, Port Fourchon in particular, are expected to experience some impacts to population and their education system as of a result of increase demand of OCS labor. As discussed in **Chapter 4.2**, a proposed action is expected have an incremental contribution of less than a 1 percent to the population level in any of the EIA's. Given both the low levels of population growth and industrial expansion associated with a proposed action, the baseline age and racial distribution pattern and education status, is expected to continue through the year 2046. Population impacts from WPA Lease Sale 200 are also expected to be less than 1 percent of total population for any EIA (USDOI, MMS, 2002a).

4.5.15.3. Economic Factors

This cumulative economic analysis focuses on the potential direct, indirect, and induced employment impacts of the OCS Program's oil and gas activities in the GOM, together with those of other likely future projects, actions and trends in the region. Most approaches to analyzing cumulative effects begin by assembling a list of "other likely projects and actions" that will be included with the proposed action for analysis. However, no such list of future projects and actions could be assembled that would be sufficiently current and comprehensive to support a cumulative analysis for all 132 of the coastal counties and parishes in the analysis area (from Texas to Florida) over a 40-year period. Instead of an arbitrary assemblage of future possible projects and actions, this analysis employs the economic and demographic projections from Woods and Poole Economics, Inc. (2006) to define the contributions of other likely projects, actions, and trends to the cumulative case. These projections are based on local, regional, and national trend data as well as likely changes to local, regional, and national economic and demographic conditions. Therefore, the projections include employment associated with the continuation of current patterns in OCS leasing activity as well as the continuation of trends in other industries important to the region. These Woods and Poole projections represent a more comprehensive and accurate appraisal of cumulative conditions than could be generated using the traditional list of possible projects actions. These projections also include Woods and Poole's assumptions regarding Hurricanes Katrina and Rita's impact on the Southeast (**Chapter 3.3.5.5**). Hence, the regional economic impact assessment methodology used to estimate changes to employment for a proposed lease sale was used for the cumulative analysis.

Tables 4-45, 4-46, and 4-47 present projected employment associated with the OCS Program and the percentage to total baseline employment in each EIA. As noted above, these baseline projections include employment resulting from the continuation of current patterns in OCS Program activities. Hence, forecasting total employment from the OCS Program and then dividing by a number that already includes all of the employment from previous Program actions significantly overestimates the impacts of the OCS Program on a percentage basis. Based on these model results, direct employment in the MMS-defined EIA associated with OCS Program activities is estimated to range between 146,000 and 204,000 jobs during peak activity years for the low and high resource estimate scenarios, respectively. Indirect employment is projected between 49,000 and 69,000 jobs, while induced employment is projected between 72,000 and 99,000 jobs for the same peak period. Therefore, total employment resulting from OCS Program activities in the MMS-defined EIA is not expected to exceed 267,000-372,000 jobs in any given year over the 40-year impact period.

Tables 4-45 and 4-46 also present projected employment for "Other-GOM" and "Other-US." Other-GOM consists of the remaining counties and parishes that are outside the MMS-defined EIA for the five Gulf States. Direct employment for this area associated with OCS Program activities is estimated to range between 60,000 and 79,000 jobs during peak activity years for the low and high resource estimate scenarios, respectively. Indirect employment is projected between 21,000 and 27,000 jobs, while induced employment is projected between 30,000 and 39,000 jobs, resulting in a total of 110,000-145,000 jobs. Other-US consists of the remaining 45 states. Total employment in the remaining states is projected to be between 210,000 and 280,000 jobs during peak activity, with 59,000-79,000 being direct employment.

In Texas, the majority of OCS-related employment is expected to occur in EIA TX-3, which also represents the largest projected employment level of any EIA. This employment is expected to never exceed a maximum of 3.6 percent of the total employment in that EIA. The OCS-related employment for Louisiana EIA's LA-2 and LA-3 is also projected to be substantial. Direct employment levels in LA-2 and LA-3 are comparable, with LA-2 slightly higher. However, the impacts on a percentage basis are much greater in LA-2, reaching a maximum of nearly 24 percent versus about 10 percent in LA-3. While these numbers are high, it is important to remember that they are overestimates for the reason discussed in the previous paragraph. Also, the percentage analysis is highly dependent on the baseline employment projections, which are somewhat dependent on the size of the EIA. The EIA LA-2 has one labor market area (Lafayette), while LA-3 has two labor market areas (Baton Rouge and Houma); it follows that the baseline employment projections for LA-2 are less than (in this case, less than half) the baseline employment projections for LA-3 and that the resulting percentage impacts in LA-2 are more than twice as high. Nonetheless, over the last decade there has been a migration to Lafayette Parish (and to a lesser extent Iberia Parish) from areas throughout coastal Louisiana, particularly in the extraction and oil and gas support sectors (Dismukes, personal communication, 2006). The next greatest impacts in percentage terms are in TX-2, LA-4, and LA-1, respectively, with none exceeding 5.1 percent in any given year. The OCS-related employment for TX-1 and all of Alabama, Mississippi, and Florida's EIA's is not expected to exceed 2.3 percent of the total employment in any EIA. Current model results for direct, and hence total, employment in Florida as well as LA-2 and LA-3 may be too high because of the existing methodology used to allocate expenditures onshore for these areas. The MMS will reexamine these results in the Final EIS. Population impacts, as conveyed in **Tables 4-43 and 4-44**, mirror those assumptions associated with employment.

Employment demand will continue to be met primarily with the existing population and available labor force in most EIA's. The vast majority of these cumulative employment estimates represent existing jobs from previous OCS-Program actions. The MMS does expect some employment will be met through in-migration; however, this level is projected to be small and localized and, thus, MMS expects the sociocultural impacts from in-migration to be minimal in most EIA's. On a regional level, the cumulative impact on the population, labor, and employment of the counties and parishes of the impact area is considerable for some focal points. Peak annual changes in the population, labor, and employment of all EIA's resulting from the OCS Program are minimal, except in Louisiana.

On on a local level, Port Fourchon is experiencing full employment, housing shortages, and stresses on local infrastructure—roads (LA Hwy 1), water supply, schools, hospitals, etc. Port Fourchon is a focal point for OCS development, especially deepwater OCS operations. As discussed in **Chapter 3.3.5.2**, the Port (and the surrounding community and infrastructure) is experiencing increased activity as a result of the 2005 hurricane season because of both the extent of repairs being made to offshore infrastructure and the damages and lost capacity at other service bases such as Venice and Cameron. Although some of this increase is expected to be temporary while repairs are being made, some of the increase is likely to be permanent. Any additional employment, particularly new residential employment, and the resultant strain on infrastructure, due to the OCS Program, are expected to have a significant impact on the area. In addition, ports throughout the Gulf are experiencing labor shortages for higher skilled positions as electricians, fitters, crane operators, and boat captains, an issue that existed prior to the 2005 hurricane season. This may lead to additional in-migration to these areas to fill these positions.

The resource costs of cleaning up an oil spill, either onshore or offshore, were not included in the above cumulative analysis. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of up to hundreds of temporary jobs. While such expenditures are revenues to business and employment/revenues to individuals, spills represent a net cost to society and are a deduction from any comprehensive measure of economic output. In economic terms, spills represent opportunity costs. An oil spill's opportunity cost has two generic components. The first cost is the direct cost to clean up the spill and to remediate the oiled area. This is the value of goods and services that could have been produced with these resources had they gone to production or consumption rather than the cleanup. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999).

Chapter 4.3.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The magnitude of the impacts discussed below depend on many factors including the season of spill occurrence and contact, the volume and condition of the oil that reaches shore, the usual use of the shoreline impacted, the diversity of the economic base of the shoreline impacted, and the time required for cleanup and remediation activities. In addition, the extent and type of media coverage of a spill may affect the magnitude and length of time that tourism is reduced to an impacted area.

The immediate social and economic consequences for a region contacted by an oil spill also included non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative, short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities.

Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). **Chapters 4.4.10 and 4.4.12** contain more discussions of the consequences of a spill on fisheries and recreational beaches.

Summary and Conclusion

The OCS Program will produce only minor economic changes in the Texas, Mississippi, Alabama, and Florida EIA's. With the exceptions of EIA's TX-2 and TX-3, it is expected to represent less than 2.3 percent of employment projected in any of the EIA's in these states. Employment associated with the OCS Program reaches 3.6 percent of total projected employment for EIA TX-3 and 5.1 percent of total projected employment for EIA TX-2. However, the OCS Program is projected to substantially impact the Louisiana EIA's LA-2 and LA-3, with OCS-related employment expected to peak at 23.8 percent and 9.8 percent of total employment, respectively. On a regional level, activities relating to the OCS Program are expected to significantly impact employment in Lafourche Parish, Louisiana, in EIA LA-3. Therefore, the population, housing, roads (LA Hwy 1), water supply, schools, and hospitals in the parish will be affected and strained.

The short-term social and economic consequences for the Gulf coastal region should a spill ≥1,000 bbl occur includes opportunity cost of employment and expenditures that could have gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill. Overall employment projected for all oil and gas activities related to the OCS Program, including employment impacts from oil spills, is projected to be substantial (particularly in EIA's TX-3, LA-2, and LA-3).

As discussed in **Chapter 4.2**, a proposed action is expected have an incremental contribution of less than a 1 percent to the employment level in any of EIA's.

Lease Sale 200 is also expected to generate less than a 1 percent increase in employment in any of the EIA's (USDOI, MMS, 2002a). This demand will be met primarily with the existing population and available labor force. On July 31, 2006, MMS revised the employment analysis for Lease Sale 200 using new data that recently became available from Woods and Poole Economics, Inc. (2006). The data supports this projection.

4.5.15.4. Environmental Justice

This analysis addresses environmental justice concerns related to cumulative impacts. These concerns center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). The MMS estimates that OCS production in during 2007-2046 will range from between 28.562 and 32.57 BBO and 142.366 and 162.722 tcf of gas (**Table 4-1**). After addressing the effects to environmental justice of the OCS Program, this section analyzes the cumulative effects of non-OCS factors that affect environmental justice in the study area. This section also considers the contribution of proposed actions in the WPA and CPA to the cumulative impacts.

Chapter 3.3.5 describes the widespread and extensive OCS-support system and associated labor force, as well as economic factors related to OCS activities. The widespread nature of the OCS-related infrastructure serves to limit the magnitude of effects that a proposed action or the OCS Program may have on any particular community. The continuing and future OCS Program will serve mostly to maintain ongoing activity levels. Generally, effects will be widely yet thinly distributed across the Gulf Coast and will consist of slightly increased employment and even more slightly increased population. For most of the Gulf Coast, the OCS Program will result in only minor economic changes. Some places could experience elevated employment, population, infrastructure, and/or traffic effects because of local concentrations of fabrication and supply operations. Lafourche Parish, Louisiana, is one community where concentrations of industry activity and related employment are likely to strain the local infrastructure.

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. In the cumulative OCS Program case, employment opportunities will increase slightly in a wide range of businesses over the entire Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. **Figures 3-21 through 3-26** provide distributions of counties and parishes of high concentrations of minority groups and low-income households. As stated in **Chapter 3.3.5.10**, pockets of concentrations of these populations scattered throughout the GOM coastal counties and parishes, most in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of OCS-related industry activity, the effects of the cumulative OCS Program are not expected to be disproportionate with regard to minority and low-income populations.

The cumulative OCS Program's widespread economic effects on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), do employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector, hence it affected white male employment more than that of women or minorities (Singelmann, personal communication, 2006). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an plant in one rural Louisiana town were much higher than reemployment rates after similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While, except in Louisiana, the OCS Program is expected to provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns infrastructure siting, which may have disproportionate and negative effects on minority and low-income populations. Since OCS lease sales help maintain ongoing levels of activity rather than expand them, no one sale will generate significant new infrastructure demand. Over the next 40 years, the cumulative OCS Program is expected to result in new pipeline landfalls, pipeline shore facilities, and gas processing plants. Because of existing capacity, no new waste disposal sites are projected for the cumulative case (Louis Berger Group, Inc., 2004).

At present, there are 126 OCS-related pipeline landfalls and 50 OCS-related pipeline shore facilities in the GOMR (**Table 3-38**). Pipeline shore facilities are small structures, such as oil metering stations, associated with pipeline landfalls. For the OCS Program, between 32 and 47 new pipeline landfalls and between 4 and 6 pipeline shore facilities are projected (**Table 4-9**). The projections mirror the current distribution landfalls: 25-36 landfalls are projected for Louisiana, which currently has 106; 6-8 are projected for Texas, which currently has 13; 1-3 are projected for Mississippi and Alabama, which currently have 7; and none are projected for Florida. For Louisiana, 3-5 pipeline shore facilities are projected, currently there are 37; 1-2 are projected for Texas, which currently has 13; 0-1 are projected for Mississippi and Alabama, which currently have none; and none for Florida. As discussed in the environmental justice analysis for oil spills (**Chapter 4.4.14.4**), existing coastal populations are not generally minority or low-income. While several Louisiana parishes in the lower Mississippi River Delta area have a higher percentage of minorities than the State average (e.g., Iberville, St. James, St. John the Baptist, and Orleans Parishes; **Figure 3-22**), the majority of Louisiana's coastline, in general, is virtually uninhabited. Furthermore, none of the coastal Louisiana parishes with a high level of OCS-related infrastructure have a higher percentage of poverty than the State average (**Figure 3-25**). It is not expected that pipeline landfalls and their associated facilities will disproportionately affect minority or low-income populations.

Generally, MMS does not address downstream activities, stopping the analysis at the point offshore product is mixed with onshore and/or imported products. The MMS projects 14 new gas-processing plants will be needed in support of the OCS Program over the next 40-years; this need will be due in part to the proposed actions addressed in this EIS. Unlike pipelines, the geographic distribution of projected gas-processing plants differs markedly from the current distribution, a reflection of the location of offshore reserves, available capacity in existing facilities, and onshore demand. Three new gas-processing plants are projected for Louisiana, which currently has 28; 2 new gas-processing plants are projected for Texas, which currently has 1; 9 new gas-processing plants are projected for Mississippi and Alabama, which currently have 6. As described in **Chapter 3.3.5.8**, the Gulf's extensive OCS-related infrastructure is widely distributed. This distribution is based on economic and logistical considerations unrelated to the distribution of concentrations of minority or low-income populations. The MMS cannot predict and does not regulate the siting of future gas-processing plants. The MMS assumes that sitings of any future facilities will be based on the same economic, logistical, zoning, and permitting considerations that determined past sitings, and that they will not disproportionately affect minority and low-income populations.

Each OCS-related facility that may be constructed onshore must receive approval by the relevant Federal, State, county or parish, and involved communities. Each onshore pipeline must obtain similar permit approval and concurrence. The MMS assumes that any onshore pipeline construction will be approved only if it is consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms. Should a conflict occur, MMS assumes that approval will not be granted or that appropriate mitigating measures will be enforced by the responsible political entities.

Chapter 3.3.5.8 describes Louisiana's extensive oil-related support system. As a result of the concentration of OCS-support infrastructure, Louisiana has experienced more employment effects than the other Gulf Coast States. In Louisiana, Lafourche Parish is likely to experience the greatest concentration, and is the community where the additional OCS-related activities and employment will be sufficiently concentrated to be significant and to affect and strain its local infrastructure. While the addition of a C-Port in Galveston, Texas, is expected to increase Texas's share of future effects, Louisiana is likely to continue to experience more effects than the other Gulf Coast States.

The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately low-income or minority (**Figures 3-22 and 3-25**). The Houma, a Native American tribe recognized by the State of Louisiana, has been identified by the MMS as a possible environmental justice concern. New MMS research indicates that minority populations throughout Lafourche Parish, Louisiana, could sustain disproportionate effects should a major accident involving onshore activities occur (Hemmerling and Colten, 2003). Five different classes of relevant OCS activities exist in the region, including transportation corridors, oil and natural gas pipelines, petroleum bulk storage facilities, shipyards, and a natural gas processing plant. The majority of OCS-related infrastructure is located in south Lafourche Parish where the Houma Indian population is concentrated. A proposed lease sale would not significantly alter this preexisting situation where onshore cumulative effects already exist. Therefore, since the preexisting situation would not be significantly altered, minority and low-income populations would not sustain disproportinate adverse effects from the proposed action.

A reevaluation of the baseline conditions pertaining to environmental justice was recently conducted as a result of recent hurricane activity in the GOM. While it is expected that hurricane activity can have severe impacts on all coastal communities, impacts on minority and low-income populations may be disproportionate to the remainder of the local population. Since the hurricanes have not forced a major shifting of the onshore infrastructure and the proposed action would predominately use existing infrastructure, no difference from the existing conditions will be evident.

Chapter 4.5.15.2 discusses the potential strains on community infrastructure and services in the following parishes and counties: St. Tammany, Louisiana; St. John the Baptist, Louisiana; St. James, Louisiana; Ascension, Louisiana; St. Charles, Louisiana; East Baton Rouge, Louisiana; Tangipahoa, Louisiana; and Stone, Mississippi. Any concentrations of poor and/or minority communities are expected to incur the same infrastructure and service strains as the overall resident population, therefore not causing disproportionate and negative effects on minority and low-income groups. The distribution of low-income and minority populations also does not parallel the distribution of OCS-related industry activity.

Two local infrastructure issues described in **Chapter 3.3.5.2** could possibly have related environmental justice concerns: traffic on LA Hwy 1 and Port Fourchon expansion. The most serious concern raised during scoping for this multisale EIS is high level of traffic on LA 1. Increased truck traffic destined for Port Fourchon physically stresses the highway, inconveniences and sometimes disrupts local communities, and may pose health risks in the form of increased accident rates and possible interference to hurricane evacuations (Keithly, 2001; Hughes et al., 2001). As described in **Chapter 3.3.5.2**, the area's "string settlement pattern" means that rich and low-income alike live on a narrow band of high ground along LA 1 and will be equally affected by any increased traffic.

Port Fourchon is relatively new and mostly surrounded by uninhabited land. Existing residential areas close to the port are new and not low-income. While the minority and low-income populations of Lafourche Parish will share with the rest of the population the negative impacts of the OCS Program, most effects are expected to be economic and positive. While the link between a healthy oil industry and indirect economic benefits to all sectors of society may be weak in some communities, in Lafourche Parish it is strong. The Parish is part of an area of relatively low unemployment due to the concentration of petroleum industry activity (Hughes et al., 2001).

Many studies of social change in the GOM coastal region suggest that the offshore petroleum industry, and even the offshore and onshore petroleum industry, has not been a critical factor except in limited in small areas for limited periods of time. This was a key conclusion of an MMS-funded study of the historical role of the industry in the Gulf, a study that addressed social issues related to environmental justice (Wallace et al., 2001). The MMS 5-Year Programmatic EIS (USDOI, MMS, 2001d) analyzed the contribution of the OCS program in the GOM (i.e., its cumulative effects) to the cumulative effects of both OCS and non-OCS factors affecting environmental justice. The MMS 5-Year Programmatic EIS notes that the characterization of the GOM's sociocultural systems suggests that the historical impacts of offshore oil and gas activities on the sociocultural environment have not been sweeping regional effects. Impacts, including how communities respond to fluctuations in industry activity, vary from one coastal community to the next. While regional impacts may be unnoticed or very limited, individual communities may or may not realize adverse sociocultural impacts. Expansion or contraction of offshore or onshore oil and gas activity has produced moderate impacts in some communities, whereas other communities have dealt with episodes of rapid industry change with negligible to minor impact. Further, non-OCS activities also have the potential for sociocultural impacts. These activities can lead to changes in social organization by being a catalyst for such things as in-migration, demographic shifts, population change, job creation and cessation, community development strategies, and overall changes in social institutions (family, government, politics, education, and religion). The MMS 5-Year Programmatic EIS analysis concludes that the cumulative environmental justice impacts from non-OCS activities have made, and will make, substantially larger contributions to the environmental justice effects than will the OCS Program.

Summary and Conclusion

Because of the presence of an extensive and widespread support system for OCS and associated labor force, the effects of the cumulative case are expected to be widely distributed and, except in Louisiana, little felt. In general, the cumulative effects of the OCS Program are expected to be economic and have a limited but positive effect on low-income and minority populations. In Louisiana, these positive economic effects are expected to be greater. In general, who will be hired and where new infrastructure might be located is impossible to predict, although a new C-Port in Galveston is likely to increase Texas's share of effects. Given the existing distribution of the OCS-related industry and the limited concentrations of minority and low-income peoples, the cumulative OCS Program will not have a disproportionate effect on these populations. Lafourche Parish will experience the most concentrated effects of cumulative impacts. Because the parish is not heavily low-income or minority and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups are not expected to be differentially affected. In general, the more concentrated cumulative impacts in Lafourche Parish are expected to be mostly economic and positive. A proposed action in the WPA or CPA is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people. In the GOM coastal area, the contribution of a proposed action and the OCS Program to the cumulative effects of all activities and trends affecting environmental justice issues over the next 40 years is expected to be negligible to minor. The cumulative effects will be concentrated in coastal areas, and particularly Louisiana. Most OCS Program effects are expected to be in the areas of job creation and the stimulation of the economy and are expected to make a positive contribution to economic justice. The contribution of the cumulative OCS Program to the cumulative impacts of all factors affecting environmental justice is expected to be minor (USDOI, MMS, 2001d); therefore, the incremental contribution of a proposed action to the cumulative impacts would also be minor.

4.6. Unavoidable Adverse Impacts of the Proposed Actions

Unavoidable adverse impacts associated with a proposed action are expected to be primarily short-term and localized in nature and are summarized below.

Sensitive Coastal Habitats: If an oil spill were to contact a barrier beach, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced. If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In some areas, wetland vegetation would experience suppressed productivity for several years. Much of the wetland vegetation would recover over time, but some wetland areas would be converted to open water. Some unavoidable impacts could occur during pipeline and other related coastal construction, but regulations are in place to minimize these impacts. Unavoidable impacts resulting from maintenance dredging, wake erosion, and other secondary impacts related to channels would occur as a result of the proposed actions.

Sensitive Offshore Habitats: If an oil spill occurred and contacted sensitive offshore habitats, there could be some adverse impacts on organisms contacted by oil.

Water Quality: Routine offshore operations would cause some unavoidable effects to varying degrees on the quality of the surrounding water. Drilling, construction, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. A turbidity plume would also be created by the discharge of drill cuttings and drilling fluids. This, however, would only affect water in the immediate vicinity of the rigs and platforms. The discharge of treated sewage from the rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and BOD in a small area near the discharge point for a short period of time. Accidental spills from platforms and the discharge of produced waters could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms.

Unavoidable impacts to onshore water quality would occur as a result of chronic point- and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of lease sale activities. Vessel traffic contributes to the degradation of impacted bodies of water through inputs of chronic oil leakage, treated sanitary and domestic waste, bilge water, and contaminants known to exist in ship paints. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to point-source discharges from support facilities such as refineries and marine terminals.

Air Quality: Unavoidable short-term impacts to air quality could occur near catastrophic events (e.g., oil spills and blowouts) due to evaporation and combustion. Mitigation of long-term effects would be accomplished through existing regulations and development of new control emission technology. However, short-term effects from nonroutine catastrophic events (accidents) are uncontrollable.

Endangered and Threatened Species: Unavoidable adverse impacts to endangered and threatened marine mammals, birds, sea turtles, mice, and the Gulf sturgeon due to activities associated with a proposed action (e.g., seismic surveys, water quality and habitat degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to endangered species are expected to be rare.

Nonendangered and Nonthreatened Marine Mammals: Unavoidable adverse impacts to nonendangered and nonthreatened marine mammals due to activities associated with a proposed action (e.g., seismic surveys, water quality degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to nonendangered and nonthreatened marine mammals are expected to be rare.

Coastal and Marine Birds: Some injury or mortality to coastal birds could result in localized areas from OCS-related oil spills, helicopter and OCS service-vessel traffic, and discarded trash and debris. Marine birds could be affected by noise, disturbances, and trash and debris associated with offshore activities. If an oil spill occurs and contacts marine or coastal bird habitats, some birds could experience sublethal impacts and birds feeding or resting in the water could be coated with oil and die. Oil spills and oil-spill cleanup activities could also affect local bird prey species.

Fish Resources and Commercial Fisheries: Losses to fishing resources and fishing gear could occur from production platform placement, oil spills, and produced-water discharges. Localized populations of fish species are expected to experience sublethal effects. This could result in a temporary decrease in a local population on a local scale. It is unlikely that fishermen would harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable. Other unavoidable adverse impacts include loss of fishing space caused by the installation of pipelines, rigs, platforms, or by other OCS-related structures.

Recreational Beaches: Even though existing regulations prohibit littering of the marine environment with trash, offshore oil and gas operations may result in the accidental loss of some floatable debris in the ocean environment; this debris may eventually come ashore on major recreational beaches. Accidental events can lead to oil spills, which are difficult to contain in the ocean; therefore, it may be unavoidable that some recreational beaches become temporarily soiled by weathered crude oil.

Archaeological Resources: As a result of the proposed actions, unique or significant archaeological information may be lost. Required archaeological surveys significantly reduce the potential for this loss by identifying potential archaeological sites prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. In some cases (e.g., in areas of high sedimentation rates), survey techniques may not be effective at identifying a potential resource.

4.7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible or irretrievable commitments of resources refer to impacts or losses to resources that cannot be reversed or recovered. Examples are when a species becomes extinct or when wetlands are permanently converted to open water. In either case, the loss is permanent.

Wetlands: An irreversible or loss of wetlands and associated biological resources could occur if wetlands are permanently lost due to impacts from dredging, construction activities, or oil spills. Dredging activities can result in direct and indirect loss of wetlands, and oil spills can damage or destroy wetland vegetation, which leads to increased erosion and conversion of wetlands to open water. Construction and emplacement of onshore pipelines in coastal wetlands could result in the loss of coastal wetlands because of mechanical destruction and because of landloss facilitated by erosion of the marsh soils.

Sensitive Offshore Resources: Oil spills and chronic low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly a reduction or even elimination of a few small or isolated populations. The proposed biological stipulations, however, are expected to eliminate most of these risks.

Fish Resources and Commercial Fisheries: Structure removal by explosives causes mortality to fish resources, including commercial and recreational species. Fish kills, including such valuable species as red snapper, are known to occur when explosives are used to remove structures in the GOM. If structure removal by explosives is continued, it will adversely impact the commercial fishing industry proximate to the removal site. However, in view of the positive impact of offshore platforms to fish resources and commercial fishing as a result of the platforms serving as artificial reefs and fish attracting devices, continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures.

Recreational Beaches: Beached litter, debris, oil slicks, and tarballs may result in decreased enjoyment or lost opportunities for enjoyment of coastal recreational resources.

Archaeological Resources: Although the impact to archaeological resources as a result of a proposed action is expected to be low, any interaction between an impact-producing factor (drilling of wells, emplacement of platforms, subsea completions, and pipeline installation) and a significant historic shipwreck or prehistoric site could destroy information contained in the site components and in their spatial distribution. This would be an irretrievable loss of potentially unique archaeological data.

Oil and Gas Development: Leasing and subsequent development and extraction of hydrocarbons as a result of the proposed actions could represent an irreversible and irretrievable commitment of nonrenewable oil and gas resources once they are consumed. The estimated amount of resources to be recovered as a result of the proposed actions is presented in **Table 4-1**.

Loss of Human and Animal Life: The OCS oil and gas exploration, development, production, and transportation are carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public safety and environmental protection. Nonetheless, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (unavoidable accidents, human error and noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal, can result in the destruction of marine life. Although the possibility exists that individual marine mammals, marine turtles, birds, and fish can be injured or killed, there is unlikely to be a lasting effect on baseline populations.

4.8. Relationship between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

In this section, the short-term effects and uses of various components of the environment in the vicinity of proposed actions are related to long-term effects and the maintenance and enhancement of long-term productivity.

Short-term refers to the total duration of oil and gas exploration and production activities, whereas long-term refers to an indefinite period beyond the termination of oil and gas production. The specific impacts of a proposed action vary in kind, intensity, and duration according to the activities occurring at any given time. Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling and well workovers occur sporadically throughout the life of a proposed action, but also result in short-term, localized impacts. Activities during the production life of a platform may result in chronic impacts over a longer period of time (over 25 years), potentially punctuated by more severe impacts as a result of accidental events. Platform removal is also a short-term activity with localized impacts; the impacts of site clearance may be longer lasting. Over the long-term, several decades to several hundreds of years, natural environmental balances are expected to be restored.

Many of the effects discussed in **Chapter 4.2** are considered to be short-term (being greatest during the construction, exploration, and early production phases). These impacts could be further reduced by the mitigation measures discussed in **Chapter 2.**

The principle short-term use of the leased areas in the GOM would be for the production of 0.242-0.423 BBO and 1.644-2.647 Tcf of gas from a typical WPA proposed action and 0.776-1.292 BBO and

3.236-5.229 Tcf of gas from a typical CPA proposed action. The short-term recovery of hydrocarbons may have long-term impacts on biologically sensitive offshore areas or archaeological resources.

The OCS activities could temporarily interfere with recreation and tourism in the region, in the event of an oil spill contacting popular tourist beaches. The proposed leasing may also result in onshore development and population increases that could cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure (**Chapters 4.2.1.1.13 and 4.2.2.1.15**, Impacts on Human Resources and Land Use). A return to equilibrium could be quickly expected as population changes and industrial development are absorbed in expanded communities. After the completion of oil and gas production, the marine environment is generally expected to remain at or return to its normal long-term productivity levels. To date, there has been no discernible decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years. The OCS development off Louisiana and Texas has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and special fish recreational equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. The proposed actions could increase these incidental benefits of offshore development. Offshore fishing and diving has gradually increased in the past three decades; platforms have been the focus of much of that activity. As mineral resources become depleted, platform removals would occur and may result in a decline in these activities. To maintain the long-term productivity of site-specific, artificial reefs attractive to fishermen and divers may need to eventually replace removed platforms.

Archaeological and historic finds discovered during development would enhance long-term knowledge. Overall, finds may help to locate other sites; but destruction of artifacts would represent long-term losses.

Extraction and consumption of offshore oil and natural gas would be a long-term depletion of nonrenewable resources. Economic, political, and social benefits would accrue from the availability of these natural resources. Most benefits would be short term and would delay the increase in the Nation's dependency on oil imports. The production of offshore oil and natural gas from the proposed action would provide short-term energy and perhaps additional time for the development of long-term alternative energy sources or substitutes for these nonrenewable resources.

Chapter 5

Consultation and Coordination

5. CONSULTATION AND COORDINATION

5.1. Development of the Proposed Actions

This EIS addresses 11 proposed Western and Central Gulf of Mexico (GOM) OCS lease sales, as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (**Figure 1.1**). The MMS conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for the proposed lease sales and EIS. Key agencies and organizations included the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Marine Fisheries Service (NOAA Fisheries Service), Fish and Wildlife Service (FWS), U.S. Coast Guard (USCG), U.S. Department of Defense (DOD), U.S. Environmental Protection Agency (USEPA), State Governors' offices, and industry groups.

5.2. Notice of Intent to Prepare an EIS and Call for Information and Nominations

On March 7, 2006, the Notice of Intent to Prepare an EIS (NOI) for the proposed Western and Central GOM lease sales was published in the *Federal Register*. Additional public notices were distributed via local newspapers, the U.S. Postal Service, and the Internet. A 45-day comment period was provided; it closed on April 21, 2006. Federal, State, and local governments, along with other interested parties, were invited to send written comments to the GOM Region on the scope of the EIS. The MMS received 65 comment letters in response to the NOI. These comments are summarized below in **Chapter 5.3.1**.

On April 28, 2006, the Call for Information and Nominations (Call) for the proposed Western and Central GOM lease sales was published in the *Federal Register*. The comment period closed on May 30, 2006. The MMS received five comment letters in response to the Call. These comments are summarized below in **Chapter 5.3.2**.

5.3. Development of the Draft EIS

Scoping for the Draft EIS was conducted in accordance with CEQ regulations implementing NEPA. Scoping provides those with an interest in the OCS Program an opportunity to provide comments on the proposed actions. In addition, scoping provides MMS an opportunity to update the GOM Region's environmental and socioeconomic information base. The scoping process officially commenced on March 7, 2006, with the publication of the NOI in the *Federal Register*. Formal scoping meetings were held in Texas, Louisiana, Alabama and Florida. The dates, times, locations, and public attendance of the scoping meetings for the proposed Western and Central Gulf lease sales were as follows:

Tuesday, March 28, 2006
1:00 p.m.
Wyndham Greenspoint
12400 Greenspoint Drive
Houston, Texas
18 registered attendees

Wednesday, March 29, 2006
1:00 p.m.
Hampton Inn and Suites
5150 Mounes Street
Harahan, Louisiana
18 registered attendees

Thursday, March 30, 2006
7:00 p.m.
Riverview Plaza Hotel
64 South Water Street
Mobile, Alabama
26 registered attendees

Thursday, April 6, 2006
1:00 p.m.
Tallahassee-Leon County Civic Center
505 Pensacola Street
Tallahassee, Florida
113 registered attendees

5.3.1. Summary of Scoping Comments

Comments (both verbal and written) were received from the NOI and four scoping meetings from Federal, State, and local governmental agencies; interest groups; industry; businesses; and the general public on the scope of the EIS, significant issues that should be addressed, alternatives that should be considered, and mitigation measures. All scoping comments received, which were appropriate for a lease sale NEPA document, were considered in the preparation of the Draft EIS. Several comments were received on impact-producing factors and environmental and socioeconomic resources and issues, which were addressed in MMS's previous lease sale NEPA documents and in this EIS. New issues included onshore and offshore impacts of past and future hurricanes, mitigation of impacts to Highway LA1 from OCS activity in Port Fourchon, locations of future public meetings (in Larose Civic Center and coastal cities in Florida including Pensacola Beach), and limiting drilling off Mississippi barrier islands.

The MMS also used the scoping meetings as an opportunity to solicit comments on the scope of the EIS for the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012* (5-Year Program). Scoping comments related to programmatic issues are listed below and have been considered in the preparation of the 5-Year EIS. The majority of the comments were in support or opposition of the 5-Year Program including reduction or expansion of the proposed sale areas. Other comments were on alternative energy, energy conservation, exotic species, global warming, objection to redrawing administrative boundaries and the reduction of Florida's jurisdiction, revenue sharing, and royalty relief.

5.3.2. Summary of Comments Received in Response to the Call

Comment letters on the Call were received by MMS from the Florida Department of Environmental Protection (DEP); Office of the Governor, State of Louisiana; BP Exploration and Production Inc.; Chevron U.S.A. Inc. (Chevron); and Shell Exploration & Production Company (Shell).

The DEP referred to two comment letters previously submitted to MMS on the Multisale EIS and 5-Year Program, which identified environmental analyses and information, and stated concerns over the movement of the administrative line.

The Office of the Governor of the State of Louisiana requested the Multisale EIS include discussions and verification of methodologies used to estimate impacts, alternative leasing schemes, revenue sharing, mitigation, and risk-based analysis of hazards faced by the Louisiana communities that serve the OCS industry. It was requested that lease sale EA's include a compensatory mitigation plan for unavoidable loss of wetlands due to OCS-related activities. The MMS was requested to prepare an economic analysis of its funding programs, a study which documents possible risk abatement measures MMS could fund for at-risk coastal communities, and provide a safety analysis of the OCS-related oil and gas infrastructure.

The three industry commenters stated support for the proposed lease sales and encouraged MMS to offer all available acreage, including unleased acreage that is not subject to Presidential withdrawal or Congressional appropriations moratoria. In addition, Chevron requested MMS to not continue the "1.4 nautical mile buffer zone" deferral once the requirement in the U.S./Mexico delimitation treaty for the former Western Gap expires (**Figure 2-1**). Chevron expressed concerns regarding implementation of the Coastal Zone Management Act (CZMA) process. In addition, Shell requested MMS work to lift the Presidential withdrawal and annual Congressional moratoria. Shell also requested that MMS work with Alabama stakeholders to gain support for leasing within 15 mi of Baldwin County, Alabama. Shell stated its support for revenue sharing with impacted coastal states and local communities while maintaining existing financial leasing and production terms.

5.3.3. Additional Scoping Opportunities

Although the scoping process is formally initiated by the publication of the NOI, scoping efforts and other coordination meetings have proceeded and will continue to proceed throughout this NEPA process. The GOM Region's ITM's provide an opportunity for MMS analysts to attend technical presentations related to OCS Program activities and to meet with representatives from Federal, State, and local agencies; industry; MMS contractors; and academia. Scoping and coordination opportunities are also available during MMS's requests for information, comments, input, and review of other MMS NEPA documents including:

- scoping and comments on the Draft Proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012*;
- requests for comments on the EA's for CPA Lease Sales 190, 194, 198, and 201;
- requests for comments on the EA's for WPA Lease Sales 184, 192, 196, and 200: and
- requests for comments on the EA for EPA Lease Sale 197.

Summary of Meeting with the State of Florida

On April 6, 2006, representatives of MMS's GOM Region met with representatives of the Florida Governor's Office to discuss any concerns the State may have regarding the proposed actions. The MMS presented an overview of the purpose of the meeting, scoping for the Draft Proposed 5-Year Program, and its related multisale EIS processes. Specifically, the MMS staff presented a plan of action for this EIS (**Chapter 2.1**, Multisale NEPA Analysis), as well as facts on the proposed lease sale areas (**Chapter 1.1**, Description of the Proposed Actions). The State mentioned the forthcoming letter from the Governor that was not yet available at the time of the meeting but was sent to MMS shortly thereafter. The concerns expressed during the meeting were the change to offshore administrative lines made without the opportunity for the State of Florida to comment and the opening of the easternmost portion of CPA sale area and south of that area as part of future leasing.

Public Meeting Held by Congressman Jim Davis

On Monday, April 3, 2006, Congressman Jim Davis hosted a public meeting to discuss offshore oil and gas drilling in the Eastern GOM. The meeting was held at 9:30 a.m. in the Tampa Port Authority's Board Room located at 1101 Channelside Drive in Tampa, Florida. A representative of Congressman Jim Davis submitted written materials and video of the Tampa meeting at MMS's scoping meeting held on April 6, 2006, in Tallahassee, Florida. The MMS was asked to give careful consideration to these materials.

The MMS viewed approximately 2 hours of video tapes that were submitted. According to the Congressman's website, nearly 100 Floridians attended the meeting including "small business owners, local business leaders, environmentalists and local government officials – many who spoke passionately about the importance of protecting our beaches" (U.S. House of Representatives, 2006). Twenty-seven speakers gave testimony following an introduction by Congressman Davis.

During the introduction, Congressman Davis stated no other state will be more affected than Florida, discussed the administrative line changes, discussed other Congressional efforts to expand east of the administrative line, stated the original Sale 181 area contains 1 year of oil and 1 1/2 years of gas, and discussed the Martinez Nelson Bill. Following the introduction, Dr. Bob Weisburg, an oceanographer, gave a presentation on Eastern GOM currents. He stated the Sale 181 area is visited regularly by the Loop Current and material entrained in the Loop Current could contact the Florida Keys and the east coast of Florida. The following is a summary of testimony of the 26 speakers that followed Dr. Weisburg:

- Support for the Martinez-Nelson Bill (the Permanent Protection for Florida Act) and its companion bill by Congressman Davis
- Most of the speakers stated they opposed oil and gas activity in the Eastern GOM because of the economic impacts to tourism and fishing.
- Many stated concerns over Florida's white beaches becoming like those in Texas and Louisiana, especially tarballs.
- Many referenced the 1993 spill in Tampa Bay.
- Though oil spills were the top concern, pollution from routine activities and illegal dumping were also mentioned.
- Concern over continued burning of fossil fuels and global warming.
- Risks are not worth the benefits.

- Concern over MMS's continued eastward movement.
- Stated Red Tide was evidence of what would happen if the proposal went forward.
- Questioned the safety of structures from hurricanes.
- Stated that the proposal was a short-term solution, and the Government should look to long-term solutions such as alternative energy sources, renewable energy sources, and conservation

In addition to the videotaped testimony, several written comments that echoed the opposition and issues presented by the speakers were submitted.

5.3.4. Cooperating Agency

According to Part 516 of the DOI Departmental Manual, MMS must invite eligible governmental entities to participate as cooperating agencies when developing an EIS in accordance with the requirements of NEPA and the CEQ regulations. The MMS must also consider any requests by eligible governmental entities to participate as a cooperating agency with respect to a particular EIS, and then to either accept or deny such requests.

The NOI published on March 7, 2006, included an invitation to other Federal agencies and State, tribal, and local governments to consider becoming cooperating agencies in the preparation of this EIS. On March 23, 2006, MMS received a request from the USEPA to participate as a cooperating agency, and MMS has accepted that request. A copy of the USEPA's request is included in Appendix D. In its request, USEPA stated that the National Pollutant Discharge Elimination System (NPDES) General Permit (GP) for the Western portion of the GOM OCS will expire on November 5, 2007. Reissuance of the GP will require the preparation of an environmental assessment under NEPA. The hypoxic zone off the coast of Louisiana and potential impacts to the Flower Garden Banks National Marine Sanctuary were two outstanding issues of concern when the GP was reissued in 2004. A Memorandum of Understanding (MOU) between MMS and USEPA was prepared and expresses each agency's respective roles, assignment of issues, schedules, and staff commitments. A copy of the MOU is included in **Appendix D**.

5.4. DISTRIBUTION OF THE DRAFT EIS FOR REVIEW AND COMMENT

The MMS will send copies of this Draft EIS to the following public and private agencies and groups. Local libraries along the Gulf Coast will also be provided copies of this document. The list of libraries and their locations is available on the MMS Internet website at http://www.gomr.mms.gov. To initiate the public review and comment period on this Draft EIS, MMS will publish a Notice of Availability (NOA) in the *Federal Register*. Additionally, public notices will be mailed with the Draft EIS and placed on the MMS Internet website. All comments received on this Draft EIS will be considered in the preparation of the Final EIS.

Federal Agencies

Congress
- Congressional Budget Office
- House Resources Subcommittee on Energy and Mineral Resources
- Senate Committee on Energy and Natural Resources

Department of Commerce
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration

Department of Defense
- Department of the Air Force
- Department of the Army
- Corps of Engineers
- Department of the Navy

Department of Energy
- Strategic Petroleum Reserve PMD

Department of the Interior
- Fish and Wildlife Service
- Geological Survey
- Minerals Management Service
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of State
- Office of Environmental Protection
- Department of Transportation
- Coast Guard
- Office of Pipeline Safety
- Environmental Protection Agency
  - Region 4
  - Region 6
- Marine Mammal Commission

State and Local Agencies

Alabama
- Governor's Office
- Alabama Highway Department
- Alabama Historical Commission and State
- Historic Preservation Officer
- Alabama Public Service Commission
- Department of Environmental Management
- Department of Conservation and Natural Resources
- South Alabama Regional Planning Commission
- State Docks Department
- State Legislature Natural Resources Committee
- State Legislature Oil and Gas Committee

Florida
- Governor's Office
- Bureau of Archaeological Research
- Department of Community Affairs
- Department of Environmental Protection
- Department of State Archives, History and Records Management
- Escambia County
- Florida Coastal Zone Management Office
- State Legislature Natural Resources and Conservation Committee
- State Legislature Natural Resources Committee
- West Florida Regional Planning Council

Louisiana
- Governor's Office
- Calcasieu Regulatory Planning Commission
- Department of Culture, Recreation, and Tourism
- Department of Environmental Quality
- Department of Natural Resources
- Department of Transportation and Development
- Department of Wildlife and Fisheries
- Louisiana Geological Survey
- State Legislature Natural Resources Committee
- State House of Representatives Natural Resources Committee

Mississippi
- Governor's Office
- Department of Archives and History
- Department of Natural Resources
- Department of Wildlife Conservation
- State Legislature Oil, Gas, and Other Minerals Committee

Texas
- Governor's Office
- Attorney General of Texas
- General Land Office
- Southeast Texas Regional Planning Commission
- State Legislature Natural Resources Committee
- State Senate Natural Resources Committee
- Texas Historical Commission
- Texas Legislation Council
- Texas Parks and Wildlife Department
- Texas Water Development Board

Libraries

Alabama
- Auburn University Library, Montgomery
- Dauphin Island Sea Lab, Marine
- Environmental Science Consortium Library, Dauphin Island
- Gulf Shores Public Library, Gulf Shores
- Mobile Public Library, Mobile
- Montgomery Public Library, Montgomery
- Thomas B. Norton Public Library, Gulf Shores
- University of South Alabama, Mobile

Florida
- Charlotte-Glades Regional Library System, Port Charlotte
- Collier County Public Library, Naples Florida
- A&M, Coleman Memorial Library, Tallahassee
- Northwest Regional Library System, Panama City
- Florida State University, Strozier Library, Tallahassee
- Fort Walton Beach Public Library, Fort Walton Beach
- Leon County Public Library, Tallahassee
- Marathon Public Library, Marathon
- Monroe County Public Library, Key West
- Selby Public Library, Sarasota
- St. Petersburg Public Library, St. Petersburg
- Tampa-Hillsborough Public Library, Tampa
- University of Florida, Holland Law Library, Gainesville
- University of Miami Library, Miami
- University of West Florida, Pensacola

Louisiana
- Calcasieu Parish Library, Lake Charles
- Cameron Parish Library, Cameron
- Grand Isle Branch Library, Grand Isle
- Iberville Parish Library, Plaquemines
- Jefferson Parish Regional Branch Library, Metairie
- Jefferson Parish West Bank Outreach Branch Library, Harvey
- Lafayette Public Library, Lafayette
- Lafitte Branch Library, Lafitte
- Lafourche Parish Library, Thibodaux
- Louisiana State University Library, Baton Rouge
- Louisiana Tech University Library, Ruston
- Loyola University, Government Documents Library, New Orleans
- LUMCON Library, Chauvin
- McNeese State University, Luther E. Frazar Memorial Library, Lake Charles
- New Orleans Public Library, New Orleans
- Nicholls State University, Nicholls State Library, Thibodaux
- Plaquemines Parish Library, Buras
- St. Bernard Parish Library, Chalmette
- St. Charles Parish Library, Luling
- St. John the Baptist Parish Library, LaPlace
- St. Mary Parish Library, Franklin
- St. Tammany Parish Library, Covington
- St. Tammany Parish Library, Slidell
- Terrebonne Parish Library, Houma
- Tulane University, Howard Tilton Memorial Library, New Orleans
- University of New Orleans Library, New Orleans
- University of Southwestern Louisiana, Dupre Library, Lafayette
- Vermilion Parish Library, Abbeville
- West Bank Regional Library, Harvey

Mississippi
- Gulf Coast Research Laboratory, Gunter Library, Ocean Springs
- Hancock County Library System, Bay St. Louis
- Harrison County Library, Gulfport
- Jackson State University, Eudora Welty Library, Jackson

Oklahoma
- University of Tulsa, McFarlin Library, Tulsa

Texas
- Abilene Christian University, Abilene
- Alma M. Carpenter Public Library, Sourlake
- Aransas Pass Public Library, Aransas Pass
- Austin Public Library, Austin
- Baylor University, Waco
- Bay City Public Library, Bay City
- Brazoria County Library, Freeport
- Calhoun County Library, Port Lavaca
- Chambers County Library System, Anahuac
- Corpus Christi Central Library, Corpus Christi
- Dallas Public Library, Dallas
- East Texas State University Library, Commerce
- Houston Public Library, Houston
- Jackson County Library, Edna
- Lamar University, Mary and John Gray Library, Lamar Station
- Liberty Municipal Library, Liberty
- Orange Public Library, Orange

Port Arthur Public Library, Port Arthur
Port Isabel Public Library, Port Isabel
R. J. Kleberg Public Library, Kingsville
Reber Memorial Library, Raymondville
Refugio County Public Library, Refugio
Rice University, Fondren Library, Houston
Rockwall County Library, Rockwall
Rosenberg Library, Galveston
Sam Houston Regional Library & Research Center, Liberty
Stephen F. Austin State University, Steen Library, Nacogdoches
Texas A&M University Library, Corpus Christi
Texas A&M University, Evans Library, College Station
Texas Southmost College Library, Brownsville
Texas State Library, Austin
Texas Tech University Library, Lubbock
University of Houston Library, Houston
University of Texas Library, Arlington
University of Texas Library, Austin
University of Texas Library, Brownsville
University of Texas Library, El Paso
University of Texas Library, San Antonio
University of Texas at Dallas, McDermott Library, Richardson
University of Texas, LBJ School of Public Affairs Library, Austin
University of Texas, Tarlton Law Library, Austin
Victoria Public Library, Victoria

Industry

American Petroleum Institute
Alabama Petroleum Council
Amerada Hess Corporation
Area Energy LLC
Baker Atlas
Bellwether Group
B-J Services Co
BP Amoco
C.H. Fenstermaker & Associates
Chevron U.S.A. Inc.
Clayton Williams Energy, Inc
Coastal Conservation Association
Coastal Environments, Inc.
Continental Shelf Associates, Inc.
Coscol Marine Corporation
Devon Energy Corp.
Dominion Exploration & Production, Inc.
Ecological Associates, Inc.
Ecology and Environment
Energy Partners, Ltd.
EOG Resources, Inc.
Escambia County Marine Resources
Exxon Mobil Production Company
Florida Petroleum Council
FNGA, FPGA and AGDF
Forest Oil Corporation
Freeport-McMoran, Inc.
Fugro Geo Services, Inc.
General Dynamics - AIS
Geo Marine Inc.
Global Industries, Ltd.
Gulf Environmental Associates
Gulf of Mexico Newsletter
Halliburton
Horizon Marine, Inc.
Industrial Vehicles International, Inc.
International Association of Geophysical Contractors
International Paper Company
J. Connor Consultants
JK Enterprises
John Chance Land Surveys, Inc.
Kelly Energy Consultants
Kerr-McGee Corporation
Midstream Fuel Service
Mote Marine Laboratory
Newfield Exploration Company
NWF Daily News
Offshore Energy Center
Offshore Operators Committee
Petrobras America, Inc.
PPG Industries, Inc.
Propane Market Strategy Newsletter
Roffers Ocean Fishing Forecast Service
Science Applications International Corporation
Seneca Resources Corporation
Shell Exploration & Production Company
Stone Energy Corporation
Strategic Management Services-USA
T. Baker Smith, Inc.
Texas Geophysical Company, Inc.
The Houston Exploration Company
Triton Engineering Services Co.
W & T Offshore, Inc.
Walker Landscaping
Washington Post
WEAR-TV

Special Interest Groups

1000 Friends of Florida
American Cetacean Society
American Littoral Society

Apalachicola Riverkeeper
Audubon Louisiana Nature Center
Audubon of Florida
Audubon Society
Bay County Audubon Society
Citizens Assoc. of Bonita Beach
Clean Gulf Associates
Coalition to Restore Coastal Louisiana
Coastal Conservation Association
Conservancy of SW Florida
Defenders of Wildlife
Earthjustice
Florida Public Interest Research Group
Florida Sea Grant College
Gulf Coast Environmental Defense
Gulf Restoration Network
Hubbs-Sea World Research Institute
Izaak Walton League of America, Inc
Louisiana State University
Mobile Bay National Estuary Program
Natural Resources Defense Council
Nature Conservancy
Pacific Marine Technology
Perdido Key Association
Population Connection
Sierra Club
South Mobile Communities Association
Southeastern Fisheries Association
The Conservancy
The Conservation Fund
The Nature Conservancy
Walton County Growth Management

Ports/Docks

Alabama
Alabama State Port Authority
Port of Mobile

Florida
Port Manatee
Panama City Port Authority
Port of Pensacola
Tampa Port Authority

Louisiana
Greater Baton Rouge Port Commission
Greater Lafourche Port Commission
Lake Charles Harbor and Terminal District
Louisiana Offshore Oil Port, LLC
Plaquemines Port, Harbor and Terminal District
Port of Iberia District
Port of New Orleans
Port of Baton Rouge
Port of Krotz Springs
Port of Shreveport-Bossier
Port of South Louisiana
St. Bernard Port, Harbor and Terminal District

Mississippi
Port Bienville
Port of Biloxi
Port of Gulfport
Port of Natchez
Port of Pascagoula
Port of Vicksburg

Texas
Brownsville Navigation District - Port of Brownsville
Port Freeport, Texas - Brazos River Harbor Navigation District
Port Aransas
Port of Beaumont
Port of Corpus Christi Authority
Port Freeport
Port of Galveston
Port of Houston Authority
Port of Isabel - San Benito Navigation District
Port Mansfield/Willacy County Navigation District
Port of Orange
Port of Port Arthur Navigation District
Port of Port Lavaca/Point Comfort
Port of Sabine Pass
Port of Texas City

5.5. Public Hearings

In accordance with 30 CFR 256.26, MMS will hold public hearings soliciting comments on the Draft EIS for proposed 2007-2012 Western and Central GOM lease sales. The hearings also provide the Secretary of the Interior with information from interested parties to help in the evaluation of potential effects of the proposed lease sales. Announcement of the dates, times, and locations of the public hearings will be included in the NOA for the Draft EIS. Notices of the public hearings will also be included with copies of the Draft EIS mailed to the parties indicated above, posted on the MMS Internet website (http://www.gomr.mms.gov), and published in local newspapers.

CHAPTER 6

REFERENCES

6. REFERENCES

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CHAPTER 7

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7. PREPARERS

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CHAPTER 8

GLOSSARY

8. GLOSSARY

Acute — Sudden, short term, severe, critical, crucial, intense, but usually of short duration.

Anaerobic — Capable of growing in the absence of molecular oxygen.

Anthropogenic — Coming from human sources, relating to the effect of humankind on nature.

API gravity — A standard adopted by the American Petroleum Institute for expressing the specific weight of oil.

Aromatic — Class of organic compounds containing benzene rings or benzenoid structures.

Attainment area — An area that is shown by monitored data or by air-quality modeling calculations to be in compliance with primary and secondary ambient air quality standards established by the USEPA.

Barrel (bbl) — A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Benthic — On or in the bottom of the sea.

Biological Opinion — FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species, in response to formal consultation under Section 7 or the endangered Species Act.

Block — A geographical area portrayed on official MMS protraction diagrams or leasing maps that contains approximately 2,331 ha (9 mi^2).

Blowout — Uncontrolled flow of fluids from a wellhead or wellbore.

Cetacean — Aquatic mammal of the order Cetacea, such as whales, dolphins, and porpoises.

Chemosynthetic — Organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthetic).

Coastal waters — Waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands — Forested and nonforested habitats, mangroves, and marsh islands exposed to tidal activity. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for birds and other animals.

Coastal zone — The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents. See also State coastal zone boundaries.

Completion — Conversion of a development well or an exploratory well into a production well.

Condensate — Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensates generally have an API gravity of 50^{o}-120^{o}.

Continental margin — The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf — General term used by geologist to refer to the continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs in the Gulf of Mexico at about 200 m water depth. The continental shelf is characterized by a gentle slope (about 0.1^{o}). This is different from the juridicial term used in Article 76 of the Convention on the Law of the Sea (see the definition of Outer Continental Shelf).

Continental slope — The continental margin province that lies between the continental shelf and continental rise, characterized by a steep slope (about 3°-6°).

Critical habitat — Specific areas essential to the conservation of a protected species and that may require special management considerations or protection.

Crude oil — Petroleum in its natural state as it emerges from a well, or after it passes through a gas-oil separator but before refining or distillation. An oily, flammable, bituminous liquid that is essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

Deferral — Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from the proposed sale.

Delineation well — A well that is drilled for the purpose of determining the size and/or volume of an oil or gas reservoir.

Demersal — Living at or near the bottom of the sea.

Development — Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Document (DOCD) — A document that must be prepared by the operator and submitted to MMS for approval before any development or production activities are conducted on a lease in the Western Gulf.

Development well — A well drilled to a known producing formation to extract oil or gas; a production well; distinguished from a wildcat or exploratory well and from an offset well.

Direct employment — Consists of those workers involved the primary industries of oil and gas exploration, development, and production operations (Standard Industrial Classification Code 13—Oil and Gas Extraction).

Discharge — Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersion — A suspension of finely divided particles in a medium.

Drilling mud — A mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up the annulus between the pipe and the walls of the borehole to a surface pit or tank. The mud lubricates and cools the drill bit, lubricates the drill pipe as it turns in the wellbore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to downhole pressures; also called drilling fluid.

Economically recoverable resources — An assessment of hydrocarbon potential that takes into account the physical and technological constraints on production and the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Effluent — The liquid waste of sewage and industrial processing.

Effluent limitations — Any restriction established by a State or the USEPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged from point sources into U.S. waters, including schedules of compliance.

Epifaunal — Animals living on the surface of hard substrate.

Essential habitat — Specific areas crucial to the conservation of a species and that may necessitate special considerations.

Estuary — Coastal semienclosed body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Eutrophication — Enrichment of nutrients in the water column by natural or artificial methods accompanied by an increase of respiration, which may create an oxygen deficiency.

Exclusive Economic Zone (EEZ) — The maritime region extending 200 nmi from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration Plan (EP) — A plan that must be prepared by the operator and submitted to MMS for approval before any exploration or delineation drilling is conducted on a lease in the Western Gulf.

Exploration well — A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present; exploratory well.

False crawls — Refers to when a female sea turtle crawls up on the beach to nest (perhaps) but does not and returns to the sea without laying eggs.

Field — An accumulation, pool, or group of pools of hydrocarbons in the subsurface. A hydrocarbon field consists of a reservoir in a shape that will trap hydrocarbons and that is covered by an impermeable, sealing rock.

Floating production, storage, and offloading (FPSO) system — A tank vessel used as a production and storage base; produced oil is stored in the hull and periodically offloaded to a shuttle tanker for transport to shore..

Gathering lines — A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical — Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geophysical survey — A method of exploration in which geophysical properties and relationships are measured remotely by one or more geophysical methods.

Habitat — A specific type of environment that is occupied by an organism, a population, or a community.

Hermatypic coral — Reef-building corals that produce hard, calcium carbonate skeletons and that possess symbiotic, unicellular algae within their tissues.

Harassment — an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, feeding or sheltering.

Hydrocarbons — Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hypoxia — Depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

Incidental take — Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (see Taking).

Indirect employment — Secondary or supporting oil- and gas-related industries, such as the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants.

Induced employment — Tertiary industries that are created or supported by the expenditures of employees in the primary or secondary industries (direct and indirect employment), including consumer goods and services such as food, clothing, housing, and entertainment.

Infrastructure — The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Jack-up rig — A barge-like, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Landfall — The site where a marine pipeline comes to shore.

Lease — Authorization that is issued under Section 8 or maintained under Section 6 of the Outer Continental Shelf Lands Act and that authorizes exploration for, and development and production of, minerals.

Lease sale — The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lease term — The initial period for oil and gas leases, usually a period of 5, 8, or 10 years depending on water depth or potentially adverse conditions.

Lessee — A party authorized by a lease, or an approved assignment thereof, to explore for and develop and produce the leased deposits in accordance with regulations at 30 CFR 250.

Marshes — Persistent, emergent, nonforested wetlands characterized by predominantly cordgrasses, rushes, and cattails.

Military warning area — An area established by the Department of Defense within which military activities take place.

Minerals — As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Nepheloid — A layer of water near the bottom that contains significant amounts of suspended sediment.

Nonattainment area — An area that is shown by monitoring data or by air-quality modeling calculations to exceed primary or secondary ambient air quality standards established by the USEPA.

Nonhazardous oil-field wastes (NOW) — Wastes generated by exploration, development, or production of crude oil or natural gas that are exempt from hazardous waste regulation under the Resource Conservation and Recovery Act (*Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes,* dated June 29, 1988, 53 FR 25446; July 6, 1988). These wastes may contain hazardous substances.

Naturally occurring radioactive materials (NORM) — naturally occurring material that emits low levels of radioactivity, originating from processes not associated with the recovery of radioactive material. The radionuclides of concern in NORM are Radium-226, Radium-228, and other isotopes in the radioactive decay chains of uranium and thorium.

Offloading — Unloading liquid cargo, crude oil, or refined petroleum products.

Operational discharge — Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator — An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Organic matter — Material derived from living plants or animals.

Outer Continental Shelf (OCS) — All submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands.

Pelagic — Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Penaeids — Chiefly warm water and tropical prawns belonging to the family Penaeidae.

Plankton — Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Platform — A steel or concrete structure from which offshore development wells are drilled.

Play — An area in which hydrocarbon accumulations or prospects of a given type occur.

Primary production — Organic material produced by photosynthetic or chemosynthetic organisms.

Produced water — Total water discharged from the oil and gas extraction process; production water or production brine.

Production — Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Province — A spatial entity with common geologic attributes. A province may include a single dominant structural element such as a basin or a fold belt, or a number of contiguous related elements.

Recoverable reserves — The portion of the identified hydrocarbon or mineral resource that can be economically extracted under current technological constraints.

Recoverable resource estimate — An assessment of hydrocarbon or mineral resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources can be brought to the surface.

Recreational beaches — Frequently visited, sandy areas along the Gulf of Mexico shorefront that support multiple recreational activities at the land-water interface. Included are National Seashores, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resorts.

Refining — Fractional distillation of petroleum, usually followed by other processing (for example, cracking).

Relief — The difference in elevation between the high and low points of a surface.

Reserves — Proved oil or gas resources.

Rig — A structure used for drilling an oil or gas well.

Royalty — A share of the minerals produced from a lease paid in either money or "in-kind" to the landowner by the lessee.

Saltwater intrusion — Saltwater invading a body of freshwater.

Sciaenids — Fishes belonging to the croaker family (Sciaenidae).

Seagrass beds — More or less continuous mats of submerged, rooted, marine, flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.

Sediment — Material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Seeps (hydrocarbon) — Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Sensitive area — An area containing species, populations, communities, or assemblages of living resources, that is susceptible to damage from normal OCS-related activities. Damage includes interference with established ecological relationships.

Shunting — A method used in offshore oil and gas drilling and production activities where expended cuttings and fluids are discharged through a downpipe, which terminates no more than 10 m from the ocean floor, rather than discharged at the ocean surface.

State coastal zone boundary — The State coastal zone boundaries for each CZMA-affected State are defined at http://coastalmanagement.noaa.gov/mystate/docs/StateCZBoundaries.pdf

Structure — Any OCS facility that extends from the seafloor to above the waterline; in petroleum geology, any arrangement of rocks that may hold an accumulation of oil or gas.

Subarea — A discrete analysis area.

Supply vessel — A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Taking — To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered or threatened species, or to attempt to engage in any such conduct (including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts). Harrassment is the most common form of taking associated with OCS Program activities.

Tension-leg platform (TLP) — A production structure that consists of a buoyant platform tethered to concrete pilings on the seafloor with flexible cable.

Total dissolved solids — The total amount of solids that are dissolved in water.

Total suspended particulate matter — The total amount of suspended solids in water.

Total suspended solids — The total amount of suspended solids in water.

Trunkline — A large-diameter pipeline receiving oil or gas from many smaller tributary gathering lines that serve a large area; common-carrier line; main line.

Turbidity — Reduced water clarity due to the presence of suspended matter.

Volatile organic compound (VOC) — Any organic compound that is emitted to the atmosphere as a vapor.

Water test areas — Areas within the Eastern Gulf where Department of Defense research, development, and testing of military planes, ships, and weaponry take place.

Weathering (of oil) — The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

APPENDICES

APPENDIX A

PHYSICAL AND ENVIRONMENTAL SETTINGS

A. PHYSICAL AND ENVIRONMENTAL SETTINGS

A.1. GEOGRAPHY AND GEOLOGY

General Description

The present-day Gulf of Mexico (GOM) is a small ocean basin with a water-surface area of more than 1.5 million square kilometers (km) (371 million acres (ac)). The greatest water depth is approximately 3,700 meters (m) (12,139 feet (ft)). It is almost completely surrounded by land, opening to the Atlantic Ocean through the Straits of Florida and to the Caribbean Sea through the Yucatan Channel. Underlying the present GOM and the adjacent coast is a large geologic basin that began forming during Triassic time (approximately 240 million years ago (Mya)) (Salvador, 1991).

The northern GOM may be divided into several physiographic subprovinces. In the OCS area, these include: the Texas-Louisiana Shelf, the Texas-Louisiana Slope, the Rio Grande Slope, the Mississippi Fan, the Sigsbee Escarpment, the Sigsbee Plain, the Mississippi-Alabama-Florida Shelf, the Mississippi-Alabama-Florida Slope, the Florida Terrace, the Florida Escarpment, and the Florida Plain (**Figure A-1**). In the GOM, the continental shelf extends seaward from the shoreline to about the 200 m (656 ft) water depth and is characterized by a gentle slope of a few meters per km (less than one degree). The shelf is wide off Florida and Texas, but it is narrower where the Mississippi River delta has extended seawards to near the shelf edge. The continental slope extends from the shelf edge to the Sigsbee and Florida Escarpments, in about 2,000-3,000 m (6,562-9,843 ft) water depth. The topography of the slope is irregular, and characterized by canyons, troughs, and salt structures. The gradient on the slope is normally 1-2 degrees, while the gradient of the Florida Escarpment may reach 45 degrees in some places. The Mississippi Fan has a gentle incline, with slopes of 4 m (13 ft) or less per kilometer (21 ft or less per mi) with the lower Mississippi Fan having an even flatter slope at 1 m or less per km (5 ft or less per mi). The Sigsbee and Florida abyssal plains (ocean floor) are basically horizontal physiographic subprovinces, and are surrounded by features with higher topography.

There are two major sedimentary provinces in the Gulf Coast Region: Cenozoic (the western and central part of the Gulf) and Mesozoic (the eastern Gulf) (**Figure A-1**). The Cenozoic Province is a clastic regime, characterized by thick deposits of sand and shale of Paleocene to Recent age (65 Mya to present) underlain by carbonate rocks (limestone, chalk, reefs) of Jurassic and Cretaceous age (205-65 Mya) (Apps et al., 1994; Salvador, 1991; Galloway et al., 1991). Approximately 45,000 wells have been drilled in the GOM. The geology has been studied in detail for the identification, exploration, and development of natural gas and oil resources. The Mesozoic Province is a largely carbonate (limestone and reefs) area that extends eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida towards the coastline of Florida. Approximately 350 wells have been drilled in the Mesozoic Province of the Federal offshore, and less is known about the subsurface geology and its natural gas and oil resource potential. Over the last 65 million years, the Cenozoic Era, clastic sediments, (sands, silts, and clays) from the interior North American continent, have entered the GOM basin from the north and west (Apps et al., 1994; Gallaway et al., 1991). The Cenozoic Era is commonly divided into 2 geologic periods – Tertiary and Quaternary. The Tertiary Period (65-1.77 Mya) comprises almost all of the Cenozoic. The most recent part is the Quaternary Period (1.77 Mya-Recent). Geologists also subdivide the Cenozoic into time periods (Epochs) of variable duration; from oldest, Paleocene, Eocene, Oligocene, Miocene, Pliocene, Pleistocene, and Holocene. The centers of thick sediment deposition shifted progressively eastward and southward through time in response to changes in the source of sediment supply. In Early Tertiary (65-24 Mya), the Rio Grande River and a system of smaller rivers (Brazos, Colorado, Nueces, etc.) draining the Texas coastal plain were the main source of sediment supply, resulting in a thick sediment accumulation in the Western GOM. In Late Tertiary (24-1.77 Mya), the center of sediment deposition shifted eastward as the Mississippi River became the major source of sediments entering the GOM. The modern Mississippi River delta complex is the present-day reflection of a depositional system that has been periodically shifting positions due to the sediment loading and up-building of the delta since early Miocene time (approximately 24 Mya). Each sedimentary layer is different, reflecting the source of the material, the climate, and the geologic processes occurring during deposition. It is estimated that greater than 15 km (9 mi) of sediments have been deposited locally beneath Texas-Louisiana continental shelf in deep basins (Martin and Bouma, 1978; Coleman et al., 1991).

To produce economically viable accumulations of oil and gas, five things must occur in the geologic setting. First, rocks must contain an enriched supply of organic material capable of forming oil and gas by the chemical and physical changes that occur during burial process (the source). Second, a rock with pores and openings sufficiently connected to hold and transmit oil or gas after it is generated (the reservoir rocks). Third, the hydrocarbons must migrate to the reservoir rocks from the source. Fourth, the layers of rock must be structurally and/or stratigraphically configured so as to capture a large accumulation of hydrocarbon resource (the trap). And fifth, the trapping structure and the reservoir rock must be overlain or configured so that the trap is sealed to prevent the escape of oil or gas (the seal).

Upper Jurassic deposits are considered the major source rocks for gas and oil generation in the GOM. Other source rocks that have been identified in the GOM that may have generated hydrocarbons are as young as Pleistocene (approximately 2 Mya).

Cenozoic Province

The plays of the Cenozoic Province extends from offshore Texas eastward across the north-central GOM to the edge of the Cretaceous Shelf Edge (commonly known as the Florida Escarpment) offshore Mississippi, Alabama and Florida. It incorporates all of the Western Planning Area (WPA), a large portion of the Central Planning Area (CPA), and the southwestern portion of the Eastern Planning Area (EPA). To date, all of the hydrocarbon production on the OCS in the Cenozoic Province is from sands ranging in age from Oligocene to Pleistocene (approximately 34-0.2 Mya).

Two major events laid the template for the structural tectonics and stratigraphy of the Cenozoic Province: the rifting and drifting of the North American Plate to form the GOM, and the periodic breaching of the land mass to the west, which allowed marine waters into the young basin. The arid climate during the Jurassic inhibited the transport of most clastic materials to the Gulf Basin, allowing for the predominance of carbonate deposition (Salvador, 1991).

Major faulting during the ocean spreading stage created a horst (high block) and graben (low block) system in the Gulf basin that was surrounded by higher more stable land mass (Salvador, 1991). During the Upper Jurassic emergent highs were exposed and subjected to erosion, while adjacent lows filled with sediment. Due to the arid conditions, shallow waters, and the isolated lows formed within the horst and graben system, the eroded sediments were transported only a short distance to the adjacent lows. Repeated flooding and evaporation of the shallow saline waters that filled the basin resulted in a thick, widespread, salt bed (Louann Salt) that was often deposited directly onto basement rocks. Through time the basin cooled, subsided, and was gradually filled with deeper water in which more carbonates (limestone, chalk, and reefs) were deposited. At the end of the Mesozoic era, the climate became more temperate which facilitated the erosion of the surrounding mountains. During the last 65 million years (Cenozoic era), several river systems brought the eroded material (clastic) into the GOM.

Because salt is less dense than sand, silt, or clay, it tends to become mobilized as denser sediments are deposited on it. The movement of salt upward pierces overlying rocks and sediment forming structures that have trapped the prolific hydrocarbon resources in the GOM. The updip sediment loading on the shelf and the upward movement of salt during the Tertiary has formed a vast canopy of mobilized salt over most of the outer continental shelf and slope sediments. Individual, isolated salt bodies are called diapirs. Sands in proximity to salt structures have the greatest potential for hydrocarbon accumulation because it is the optimum zone for the successful cross strata migration and accumulation of oil and gas. First, salt structures create pathways for migration of hydrocarbon from Upper Jurassic, Lower Cretaceous, and/or Lower Tertiary source beds to the reservoir sands. Second, thick sands deposited in deltas or in deep sea fans with good porosity (pore space between the sand grains where oil and gas can accumulate) and permeability (connections between the pore spaces through which oil and gas can flow) provide reservoir space. Third, impermeable shales, salt, and/or faults serve as seals for trapping of oil and gas in the pore spaces of the reservoir rocks.

The hydrocarbon-producing horizons on the continental shelf and slope of the Cenozoic Province are mainly Miocene, Pliocene, and Pleistocene. The MMS has assessed 28 plays in the Cenozoic Province; 27 proven and 1 conceptual play. The Cenozoic productive intervals become thinner with less hydrocarbon potential eastward in the direction of the Cretaceous shelf edge (Mesozoic Province). The Mesozoic section has been penetrated by wells in the overlap area of the Cenozoic/Mesozoic Provinces with commercial hydrocarbons being identified in several fields.

Mesozoic Province

The Mesozoic Province in the OCS extends eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida towards the coastline of Florida (**Figure A-1**). Although this area has experienced limited drilling and most control points are on the shelf, some general statements can be made concerning resources. This province is dominated by Mesozoic carbonate rocks overlain by some Cenozoic clastic sediments. The geologic age of the sediments above basement rock ranges from the Triassic to recent marine sediments at the seafloor. The hydrocarbon potential has been realized throughout the entire geologic interval from the very shallow, young portion of the Tertiary Pleistocene (1,500-4,000 ft; 458-1,220 m), to the intermediate Cretaceous James (14,000-16,000 ft; 4,270-4,880 m) and the deep, older Jurassic Norphlet (15,000-24,000 ft; 4,575-7,320 m). Approximately two dozen fields in the Mesozoic Province produce gas from the shallow Cenozoic. In the area offshore of the Florida Panhandle (Pensacola and Destin Dome), a total of 34 wells have been drilled, with 18 of the wells penetrating the Norphlet Formation. The depths at which the Norphlet Formation is found in the Gulf coast region varies from less than 5,000 ft (1,525 m) onshore to more than 24,000 ft (7,320 m) subsea offshore Mississippi and 15,000 ft (4,575 m) subsea in Apalachicola Embayment.

This province has several potential Mesozoic hydrocarbon plays that are downdip equivalents of onshore productive fields. Carbonate rocks often require favorable diagenesis (physical and chemical alterations to the sediments after deposition), faulting, fracturing, and stratigraphy to enhance the low porosity and permeability. The variability of the porosity and permeability within a carbonate rock increases the risk in the determination of potential drainage area, production rates, and resource volume when hydrocarbons are discovered.

To date, the only discovered Mesozoic fields in the OCS are the Jurassic Norphlet (14 fields), the Cretaceous James (9), and the Cretaceous Andrew (1). Most of these fields are located in the northeastern portion of the CPA. The MMS has identified 24 plays in the Mesozoic Province: 3 proven and 21 conceptual.

Exploration and development in the GOM have resulted in the naming of more than 1,270 fields, of which 1,053 were identified, produced, or developed in the GOM. The *Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf, 2006* (USDOI, MMS, 2006a) states that, as of January 1, 2003, the mean Undiscovered Technically Recoverable Resources (UTRR) for all plays in the GOM's OCS is estimated to be 86.30 billion barrel of oil equivalent (BBOE).

Deep Gas (Continental Shelf)

The clastic sediments of the GOM are deposited mostly in deltaic environments of sands and shales that are influenced by the location of the sediment source, morphology of the seabed, and the edge of the shelf. Usually the most abundant reservoir rocks are deposited as channel or delta front sands on the shelf. Shifting of the delta complex and ocean currents tend to widely disperse these sands laterally along the shelf. Drilling on the shelf targeted these sands as potential hydrocarbon traps. It was a general belief that on the slope and abyssal fans the sands gradually became less dense and less continuous further from the proximity of the channels.

The present-day shelf was once the slope environment during the Oligocene and Miocene age (approximately 34-5.3 Mya). The shelf area holds the potential for deepwater delta systems with channels, distributary bars, levees, overbank deposits, and large fan lobes in the older and deeper section. Subsequent faulting and salt movement created traps and supplied conduits for the migration of hydrocarbons. These reservoirs would be subjected to high pressures and temperatures with increasing depth and burial history. Pore pressure increases with depth because of the overburden of the sediments and the amount of water trapped within the sediments. Temperature also increases with depth and can be even higher in areas with less salt intrusions into the sediments. The presence of salt has a cooling effect on the surrounding sediments, causing areas with salt intrusions to have lower temperatures. It is anticipated that these older, deeper reservoirs will be more likely located adjacent to or under the present shelf fields.

The shelf off the western and central Louisiana coast is also prospective for the older and deeper Mesozoic age reservoir rocks. These rocks would also be under extreme pressure and high temperatures because of their depth. The Mesozoic environment of deposition on the shelf is projected to be shallow water carbonates and reefs.

Deep Water (Continental Slope and Abyssal Plain)

The continental slope, in the GOM, extends from the shelf edge to approximately 2,000 m (6,562 ft) water depth. The seafloor gradient on the slope varies from 3-6 degrees to in excess of 20 degrees in places along the escarpments. At the base of the Cenozoic Province slope is an apron of thick sediment accumulation referred to as the continental rise. It gently inclines seaward with slopes of less than 1 degree, into the abyssal plain.

Bathymetric maps of the continental slope in the northwestern GOM (Bryant et al., 1990; Bouma and Bryant, 1994) reveal the presence of over 105 intraslope basins with relief in excess of 150 m (492 ft), 28 mounds, and 5 major and 3 minor submarine canyons. These intraslope basins occupy much of the area of the continental slope.

The middle and lower portions of the Cenozoic Province continental slope contain a canopy of salt, which has moved down-slope in response to sediment loading on the shelf and upper slope. The Sigsbee Escarpment is the southern edge of the canopy within the GOM. The lower continental slope contains eight submarine canyons and the Sigsbee Escarpment, each feature evolving from, in part, the coalescing and migration of salt canopies, an unusual process for the formation of submarine canyons (Bouma and Bryant, 1994; Bryant et al., 1990; Bryant et al., 1991).

The geology and topography of the near-surface continental slope (which is the area of greatest concern with regard to submarine slope stability) offshore Texas and Louisiana result from an interplay between episodes of rapid shelf edge progradation and contemporaneous modification of the sea bed by diapirism and mass-movement processes. Many slope sediments have been uplifted, folded, fractured, and faulted by diapiric action. Between diapirs (topographic highs) were fairways for sand-rich channels. Oversteepening on the basin flanks and resulting mass movements have resulted in the appearance of highly overconsolidated sediments underlying extremely weak pelagic sediments. The construction of the Mississippi Canyon is in part a function of sidewall slumping and pelagic draping of low-shear-strength sediments. In contrast, slope oversteepening and subsequent mass movement have resulted in high pore pressures in rapidly deposited debris flows on the upper slope and on basin floors, resulting in unexpected decreased shear strengths. Biologically generated gas (from microbial activity) and thermally generated gas (from burial maturation) induces the accumulation of hydrates and underconsolidated gassy sediments, which are common on the upper slope. On the middle and lower slope, gassy sediments are uncommon except in basins that do not have a salt base, such as Beaumont Basin; the salt canopy restricts the upward movement of gas from below.

Sands that are deposited in the shelf environment could be flushed from the shelf to the slope environment because of tectonic or other activity. Sands can also bypass the shelf and be deposited directly in the slope environment because of the physiographic framework of the shelf. Seismic interpretation (DeVay et al., 2000) and drilling in the deep waters of the GOM over the last 30 years have proven that prolific sands can be deposited in the slope environment and probably on the abyssal plain. Some of the largest fields in the GOM (Thunder Horse (Mississippi Canyon Block 778), Mad Dog (Green Canyon Block 826), Mars (Mississippi Canyon Block 807), Ursa (Mississippi Canyon Block 810), Auger (Garden Banks Block 426), Ram-Powell (Viosca Knoll Block 956), etc.) have hydrocarbon accumulations in sands deposited in the slope environment.

Piston cores are a means to sample the surficial few meters of sediment on the seafloor. Holocene and Pleistocene piston cores recovered from the continental slope off Texas and Louisiana and from Deep Sea Drilling Project activities indicate the presence of unconsolidated gassy clays, silty clays, sands, and clayey sands, many containing gas hydrates. Gas hydrates are a naturally occurring “ice-like” combination of natural gas and water (gas trapped in ice crystals) that have the potential to be a significant new source of energy from the world’s oceans and polar regions. The gas hydrates form under low temperature and high pressure when natural gas comes into association with water, such as in the deep waters of the continental margins of the GOM. Most Pleistocene cores recovered on the slope contain hemipelagic (fine-grained) sediments with lesser amounts of turbidities and debris flow material.

Holocene sediments on the middle and lower portions of the slope are usually less than a meter thick, but on the upper slope these sediments are found to be several meters thick (Silva et al., 1999).

The submarine canyons along the Sigsbee Escarpment (Alaminos, Keathly, Bryant, Cortez, Farnella, and Green Canyons) are the result of the coalescing of salt canopies, the migration of the salt over the abyssal plain, and erosion of the escarpment during periods of low-stand sea level (Bryant et al., 1991). In addition to these large submarine canyons, numerous small submarine canyons and gullies and large slumps occur along the escarpment. Submarine fans of various sizes extend seaward of the canyons onto the continental rise. Although slopes in excess of 15 degrees are found, the majority of the slopes along the canyon walls and the escarpment range from 5 to 10 degrees.

The major faults on the OCS are extensional faults, referred to as "growth faults," that form contemporaneously with rapid accumulation of massive volumes of sediments. Growth faults are found mostly on the outer shelf and upper slope where sediment accumulation is thickest (Rowan et al., 1999). Faulting resulting from the formation of salt diapirs is the most common type of faulting on the upper slope. On the middle and lower continental slope, faulting related to salt-stock and salt canopies is the most common type of faulting. Extensive faulting is present on the rim of most intraslope-interlobal and supralobal basins on the middle and lower continental slope. These faults are extensional faults caused by the upward movement of salt resulting from pressures created by sediment accumulation within basins. This type of faulting results in the occurrence of a large number of small faults in the area of the seafloor undergoing extension. In some areas of the slope, the upward migration of salt results in the seafloor being extensively fractured (i.e., faulted) and continuously displaced.

Portions of some of the submarine canyons (e.g., Bryant Canyon) are being filled with salt. Turbidity current flows that are active during times of low-stand sea level create the canyons. Subsequently, sediments that accumulate on the margins of the canyon create a differential loading on the salt causing the salt to migrate into the canyon. The migration of salt into the canyon can occur at a rate of centimeters (cm) or inches (in) per year. On the middle and lower continental slope, salt may occur very close to the seafloor. For example, on the salt plug called "Green Knoll," salt is exposed at the seafloor and is being dissolved by seawater, resulting in the collapse of the cap of the knoll. In the intraslope-interlobal Orca Basin, salt is exposed at the bottom of the northern portion of the basin forming a famous brine pool.

The most prolific play in the deepwater continental slope is identified to be the deposits of slope-fan environment ranging in age from Oligocene to Pleistocene. Recent drilling near the Sigsbee Escarpment indicates a large potential of hydrocarbons associated with the emerging Paleogene (Paleocene-Oligocene) Play. However, several technical issues have to be overcome to assure that the play is economical.

Also, efforts are made to assess natural gas resource potential from hydrates in the GOM. The MMS has a three-pronged effort with regard to methane hydrates focusing on (1) resource assessment and evaluation; (2) environmental assessment, protection, and monitoring; and (3) exploration and production activities, including offshore safety.

Hydrates have been observed and sampled from the GOM OCS in association with naturally-occurring oil and gas seeps in localized deepwater areas of very cold temperature and high pressure at or near the seafloor. In the GOM and the Atlantic OCS, hydrates have been studied for two decades by academia, the oil industry, and MMS. Naturally-occurring seep features, including hydrates, result in higher seismic amplitude (higher reflectivity). Most hydrate occurrences in the GOM are associated with deep-seated faulting, which penetrates the seafloor. These faults provide migration pathways for gas to reach the zone where hydrates are stable. The geothermal gradient increases with depth, allowing ideal temperatures only in the upper couple thousand feet of sediments for hydrates to be stable.

Geologic Hazards

The seafloor geology of the GOM reflects the interplay between episodes of diapirism, mass sediment movement, and sea-level fluctuations. Geologic features on most of the continental shelf (shoreline to about 200-m (656-ft) water depth) are simple and uniform. The main hazards in this area are faulting, shallow-gas pockets, and buried channels. Deepwater regions in the GOM have complex regional salt movement, both horizontal and vertical, which makes it a unique ocean basin. This movement greatly alters the seafloor topography forming sediment uplifts, mini-basins, and canyons. Salt moves horizontally like a glacier and can be extruded to form salt tongues, pillows, and canopies below an ever-increasing weight of sediment. Vertical salt forms range from symmetric bulb-shaped stocks to walls. While salt creates traps that are essential to petroleum accumulation, salt movement can cause potential hazards such as seafloor fault scarps, slumping from steep unstable slopes, shallow gas pockets, seeps and vents, and rocky or hard bottom areas.

Gas hydrates (gas trapped in ice crystals) have been found in the GOM in localized deepwater areas of very cold temperature and high pressure at or near the seafloor. Gas hydrates can rapidly dissociate when heated or otherwise disturbed (for example, by an anchor) and cause sediment instability. Although the GOM has had no drilling incident associated with hydrates, they are a problem in other parts of the world.

The Mississippi River delta presents a unique set of geologic hazards because of high sedimentation rates, which cause very unconsolidated, high-water-content, and low-strength sediments. Under these conditions, the sediments can be unstable, and slope failure or mass transport of sediments can result. These failures can be triggered by cyclic leading associated with hurricanes, overloading or oversteepening of the slope sediments, or uplift associated with movement of salt. These failures can form mudflow gullies, overlapping mudflow lobes, collapse depressions, slumps, and slides. Small, buried, river channels can result in differential sediment compaction and pose a hazard to jackup rigs.

Over-pressure conditions in a sedimentary section can result from loading by rapid deposition, sand collapse, in-leaking gas, or salt tectonics. Drilling through an over-pressured shallow-gas pocket can cause loss of mud circulation or a blowout (a blowout occurs when improperly balanced well pressure results in sudden uncontrolled release of fluids from a well bore or well head). A shallow water flow can cause similar drilling problems. Over-pressured conditions can develop in deepwater when “water sand” is trapped by a shale seal. Over-pressured formation water may escape around or through the wellbore to the seafloor and wash out the well foundation. No shallow water flow event in the GOM has resulted in an oil spill.

Deep drilling may encounter abnormally high geopressures. Deep drilling may also encounter hydrogen sulfide, which can occur near salt domes overlain by caprock and is the product of sulfate reducing microbes.

Potential Mitigation Measures

The best mitigation for most hazards is avoidance after detection by a geophysical survey. Leaseholders are required to run geophysical surveys before drilling in order to locate potential geologic or man-made hazards (CFR 250.203). In deepwater, most companies do a remotely operated vehicle (ROV) inspection of the seafloor for a pre-spud location. Companies are also required to take and analyze sediment borings for platform sites. Areas of hydrogen sulfide occurrences can be predicted and sensors installed on drilling rigs to warn operators. Certain leases also require archaeological surveys and live-bottom surveys to protect sensitive areas. Every application for permit to drill a well in the GOM is reviewed by MMS geologists, geophysicists, and engineers to ensure compliance with standard drilling practices and MMS regulations. All rigs and platforms are inspected by the MMS on a regular basis to ensure all equipment and procedures comply with Federal regulations for safety and environmental protection.

Geologic Condition	Hazard	Mitigations
Fault	Bend/shear casing Lost circulation Gas conduit	Stronger casing/heavier cement
Shallow Gas	Lost circulation Blowout Crater	Kill mud Pilot hole Circulate mud/drill slower Blow-out preventer/diverter Pressure while drilling log
Buried Channel	Jack-up leg punch through	Pre-load rig Mat support All rig legs in same type of sediment
Slump	Bend/shear casing	Thicker casing Coil/flexible pipeline
Water Flow	Erosion/washout Lost circulation	Kill mud, foam cement Pilot hole Pressure while drilling

A.2. Physical Oceanography

The GOM is a semi-enclosed, subtropical sea with an area of approximately 1.5 million km^2 (371 million ac). The main physiographic regions of the Gulf Basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, abyssal plains, the Yucatan Channel, and Florida Straits. The continental shelf width along the U.S. coastline is about 10 mi (16 km) off the Mississippi River, and 97 mi (156 km) off Galveston, Texas, decreasing to 55 mi (88 km) off Port Isabel near the Mexican border. The depth of the central abyss ranges to approximately 3,700 m (12,139 ft). The water volume of the entire Gulf, assuming a mean water depth of 1 mi (2 km), is 2 million km^3. The water volume of the continental shelf, assuming a mean water depth of 50 m (164 ft), is 25,000 km^3.

The Loop Current, the dominant circulation feature in the Gulf, enters through the Yucatan Channel and exits through the Florida Straits. The sill depth at the Florida Straits is about 700 m (2,300 ft); the effective sill depth at the Yucatan Channel is nearly 2,000 m (6,560 ft) (Badan et al., 2005). Water masses in the Atlantic Ocean and Caribbean Sea that occur at greater depths cannot enter the GOM. The Loop Current is a part of the western boundary current system of the North Atlantic. This is the principal current and source of energy for the circulation in the Gulf. The Loop Current has a mean area of 142,000 km^2 (35 million ac) (Hamilton et al., 2000). It may be confined to the southeastern GOM or it may extend well into the northeastern or north-central Gulf (**Figure A-2**), with intrusions of Loop Current water northward and on to the West Florida Shelf (Vukovich, 2005).

Closed rings of clockwise-rotating (anticyclonic) water, called Loop Current Eddies (LCE's) separate from the Loop Current at intervals of 5 to 19 months (Vukovich, 2005). These LCE's are also called warm-core eddies, since they surround a central core of warm Loop Current water. The Loop Current usually penetrates about as far north as 27^{o}N. latitude just prior to shedding an LCE (Vukovich, 2005). Studies on the frequency of Loop Current intrusions into the eastern Gulf and the frequency of LCE separation (Sturges, 1994; Vukovich, 2005) suggest these are chaotic processes. Currents associated with the Loop Current and its eddies extend to at least depths of 700 m (2,300 ft), the sill depth of the Florida Straits, and geostrophic shear is observed to extend to the sill depth of the Yucatan Channel. These features may have surface speeds of 150-200 cm/s (59-79 in/s) or more; speeds of 10 cm/s (4 in/s) are not uncommon at a depth of 500 m (1,640 ft) (Cooper et al., 1990). The average diameter of warm-core eddies is about 200 km (124 mi), and they may be as large as 400 km (249 mi) in diameter. Warm-core eddies can have life spans of one year or more (Elliot, 1982). Therefore, their effects can persist at one location for long periods – weeks or even months (e.g., Nowlin et al., 1998). After separation from the Loop Current, these eddies often translate westward across the GOM at a speed of about 5 km/day (3 mi/day) (range 1-20 km/day (0.6-12.4 mi/day)). Energetic, high-frequency currents have been observed when LCE's flow past structures, but they are not well documented. Such currents would be of concern to offshore operators because they could induce structural fatigue of materials. Loop Current eddies decay and generate secondary cyclones and anticyclones (SAIC, 1988) by interactions with boundaries, ring shedding, and ring-ring interactions. The net result is that, at almost any given time, the Gulf is populated with numerous eddies, which are interacting with one another and with the margins (SAIC, 1988; Hamilton and Lee, 2005).

Cold-core cyclonic (counter-clockwise rotating) eddies have been observed in the study region as well. These cyclones are often cold-core eddies, since they surround a central core of seawater that is cooler and fresher than adjacent waters. Cyclonic circulation is associated with upwelling, which brings cooler, deeper water towards the surface. A cyclone will form north of an LCE encountering northern GOM bathymetry because of off-shelf advection (Frolov et al., 2004). Cyclones are also associated with the Loop Current (Schmitz, 2005). Small cyclonic eddies around 50-100 km (31-62 mi) in diameter have been observed over the continental slope off Louisiana (Hamilton, 1992). These eddies can persist for 6 months or longer and are relatively stationary.

Near the bottom of the Loop Current, velocities are low and fairly uniform in the vertical although with bottom intensification, a characteristic of topographic Rossby Waves (TRW's). This indicates that the Loop Current is in fact a source of the TRW's, which are a major component of deep circulation below 1,000 m (3,281 ft) in this part of the Gulf (Sturges et al., 1993; SAIC, 1989; Hamilton, 1990). Exchange of surface and deep water occurs with descent of surface water beneath the Loop Current in the eastern GOM and with the ascent of deep water in the northwestern GOM where Loop Current eddies spin down (Welsh and Inoue, 2002). The Sturges et al. (1993) model suggests a surprisingly complex circulation pattern beneath LCE's, with vortex-like and wave-like features that interact with the bottom topography (Welsh and Inoue, 2000). These model findings are consistent with Hamilton's (1990) interpretation of observations.

Occasionally currents have been directly measured at abyssal depths exceeding 3,000 m (9,843 ft) in the GOM. The major low-frequency fluctuations in velocity of these currents in the bottom 1,000-2,000 m (3,281-6,562 ft) of the water column have the characteristics of TRW's. These long waves have wavelengths of 150-250 km (93-155 mi), periods greater than 10 days, and group velocities estimated at 9 km/day. They are characterized by columnar motions that are intensified near the seafloor. They move westward at higher group velocities than the translation velocity of 3-6 km/day (2-4 mi/day) that is typical of anticyclonic eddies. The Loop Current and LCE's are thought to be major sources of these westward propagating TRW's (Hamilton, 1990; Oey et al., 2004). These TRW's transition from short to longer period in going from east to west over the GOM basin, probably because of bottom slope and regional bathymetric conditions (Donohue et al., in preparation).

In general, past observations of currents in the deepwater GOM have revealed decreases in current speed with depth. During late 1999, a limited number of high-speed current events, at times approaching 100 cm/s (39 in/s), were observed at depths exceeding 1,500 m (4,921 m) in the northern GOM (Hamilton and Lugo-Fernandez, 2001; Hamilton et al., 2003). Furrows oriented nearly along depth contours have been observed recently in the region of 90° W. longitude just off the Sigsbee Escarpment and near the Bryant Fan, south of Bryant Canyon, from 91° to 92.5° W. longitude. Depths in those regions range from 2,000 to 3,000 m (6,562-9,843 ft). Speculation based partly on laboratory experimentation is that near-bottom speeds of currents responsible for the furrows that are closest to shore might be 50 cm/s (20 in/s), and possibly in excess of 100 cm/s (39 in/s), and these currents may be oriented along isobaths and increase in strength toward the escarpment. These currents might be sporadic or quasi-permanent.

Mean deep (~2,000 m (~6,562 ft)) flow around the edges of the GOM circulates in a cyclonic (counterclockwise) direction (Sturges et al., 2004). A net counterclockwise circulation pattern was also observed at about 900-m (2,953 ft) depth around the borders of the GOM (Weatherly, 2004).

In deepwater, several oil and gas operators have observed very high-speed currents in the upper portions of the water column. These high-speed currents can last as long as a day. Such currents may have vertical extents of less than 100 m, and they generally occur within the depth range of 100-300 m (328-984 ft) in total water depths of 700 m (2,297 ft) or less over the upper continental slope. Maximum speeds exceeding 150 cm/s (59 in/s) have been reported. The mechanisms by which these currents are generated may include motions derived from the Loop Current and associated eddies, motions due to eddy-eddy and/or slope-shelf/eddy interaction, internal/inertial wave motions, instabilities along eddy frontal boundaries, and biases in the data record related to instrument limitations (DiMarco et al., 2004).

The major large-scale permanent circulation feature present in the Western and Central GOM is an anticyclonic (clockwise-rotating) feature oriented about ENE-WSW with its western extent near 24^o N. latitude off Mexico. There has been debate regarding the mechanism for this anticyclonic circulation and the possible associated western boundary current along the coast of Mexico. Elliott (1982) attributed LCE's as the primary source of energy for the feature, but Sturges (1993) argued that wind stress curl over the western Gulf is adequate to drive an anticyclonic circulation with a western boundary current. Sturges (1993) found annual variability in the wind stress curl corresponding to the strongest observed boundary current in July and the weakest in October. Based on ship-drift data, Sturges (1993) showed the maximum northward surface speeds in the western boundary current were 25-30 cm/s (10-12 in/s) in July and about 5 cm/s (2 in/s) in October; the northward transport was estimated to vary from 2.5 to 7.5 m^3/s. He reasoned that the contribution of LCE's to driving this anticyclonic feature must be relatively small. Others have attributed the presence of a northward flow along the western Gulf boundary to ring-slope-ring interactions (Vidal et al., 1999).

Tropical conditions normally prevail over the Gulf from May or June until October or November. Hurricanes increase surface current speeds to 100-150 cm/s (40-59 in/s) over the continental shelves and cool the surface waters in much the same way as do cold fronts, but may stir the mixed layer to an even greater depth. Wind events such as tropical cyclones (especially hurricanes), extra tropical cyclones, and cold-air outbreaks can result in extreme waves and cause currents with speeds of 100-150 cm/s (40-59 in/s) over the continental shelves. Examples for the Texas-Louisiana shelf and upper slope are given in Nowlin et al. (1998), and for the Alabama shelf during Hurricane Ivan in Mitchell et al. (2005). Other researchers (e.g., Brooks, 1983 and 1984) have measured the effects of such phenomena down to depths of 700 m (2,297 ft) over the continental slope in the northwestern Gulf. Hurricanes can trigger a series of internal waves with near inertial period. Surface waves and sea state may limit normal oil and gas operations as well as oil-spill response activities (French et al., 2005; Fingas, 2001). Waves as high as 91 ft (28 m) were measured under Hurricane Ivan (Wang et al., 2005).

Cold fronts, as well as diurnal and seasonal cycles of heat flux at the air/sea interface, affect near-surface water temperatures, although water at depths greater than about 100 m (328 ft) remains unaffected by surface boundary heat flux. Water temperature is greater than air temperature at the air/sea interface during all seasons. Frontal passages over the region can cause changes in temperature and velocity structure in the upper layers, specifically increasing current speeds and variability. These fronts tend to occur with frequencies from 3 to 10 days (weatherband frequency). In the winter, the shelf water is nearly homogeneous due to wind stirring and cooling by fronts and winter storms.

Continental shelf waves may propagate along the continental slopes of the GOM. These are long waves similar to TRW's, but their energy is concentrated along a sloping bottom with shallow water to the right of the direction of propagation, and because of this constraint they are effectively "trapped" by the sloping bottom topography. Cold water from deeper off-shelf regions moves onto and off of the continental shelf by cross-shelf flow associated with upwelling and downwelling processes.

A class of energetic surface currents previously unreported in the GOM were found over the Texas and Louisiana shelves during the MMS-sponsored Texas-Louisiana Shelf Circulation and Transport Process (LATEX) program of the early 1990's (Nowlin et al., 1998). July 1992 observations in 200 m (656 ft) water offshore of Louisiana were of maximum amplitudes of 40-60 cm/s (16-27 in/s) at a depth of 12 m (39 ft) during conditions of light winds. The period of diminished amplitudes followed an atmospheric frontal passage. These are near-circular, clockwise-rotating oscillations with a period near 24 hours. They seem to be an illustration of thermally induced cycling (DiMarco et al., 2000) in which high-amplitude rotary currents can exist in thin mixed layers typical of summer. By contrast, December 1992 measurements evidence no such behavior. Many examples of such currents, in phase at distinct locations, exist for the Texas-Louisiana shelf and, by implication, farther offshore. Currents at a depth of 1 m (3 ft) have been observed to reach 100 cm/s (40 in/s). In deep water regions of the Gulf, clearly episodic wind events can cause major currents in the deep waters of the Gulf. The initial currents give rise to inertial oscillations with decreasing amplitudes, which last for up to about 10 days and are superimposed on longer period signals.

Inner-shelf currents on the Louisiana-Texas continental shelf flow in the downcoast (south or west) direction during non-summer months, reversing to upcoast flow in the summer (Cochrane and Kelly, 1986; Nowlin et al., 2005). Modeling results show that the spring and fall reversals in alongshore flow can be accounted for by local wind stress alone (Current, 1996). Monthly averaged alongshore currents on the outer shelf are upcoast in the mean, but showed no coherent pattern in the annual signal and were not often in the same alongshore direction at different outer-shelf locations (Nowlin et al., 1998). Mean cross-shelf geostrophic transport observed at the Louisiana-Texas shelf break was offshore during the winter (particularly in the upper 70 m (230 ft) of the water column), and onshore during the summer (Current and Wiseman, 2000).

Circulation on the continental shelf in the northeastern GOM has been observed to follow a cyclonic pattern, with westward alongshore currents prevailing on the inner and middle shelf and opposing alongshore flow over the outer shelf and slope (Brooks, 1991). Inner shelf currents are primarily wind driven and are also influenced by river outflow and buoyancy forcing from water discharged by the Mississippi, Apalachicola, Tombigbee, Alabama, and other rivers in the region. Cold water from deeper off-shelf regions moves onto and off of the continental shelf by cross-shelf flow associated with upwelling and downwelling processes. Upwelling of nutrient rich, cold water onto the shelf in 1998 was correlated with hypoxia, anoxia, and mass mortalities of fishes and invertebrates in the region, although causation has not been established (Collard and Lugo-Fernandez, 1999).

Mean circulation on the West Florida inner shelf tends to be along the coast towards the southeast during the winter, and reverses to be along coast towards the northwest during the summer. These seasonal means in flow direction are because of the influence of seasonal local winds and heat flux forcing. Midshelf flow (around the 50-m (164-ft) isobath) can be in the opposite direction from inner shelf flow on the broad, gently sloping West Florida shelf because of the partial closure imposed by the Florida Keys to the south. The outer shelf is an area of transition between deepwater currents over the continental slope and the shelf regime. The nearshore regions are influenced by freshwater outflow from rivers and estuaries. Mississippi River water is advected onto the West Florida shelf at times in spring and summer because of strong currents along the shelf break. Fresh water from the Mississippi River is sometimes entrained by the Loop Current as well (Weisberg et al., 2005).

Historical hydrographic cruises include several surveys of the entire GOM in the 1960's (including *R.V. Hidalgo* 62-H-3, *R.V. Geronimo* 67-G-12 and *R.V. Geronimo* 67-G-16) from which nearly synoptic circulation for the entire Gulf can be inferred. In addition to these synoptic cruises, a number of hydrographic cruises of more limited scope were carried out in the northeast GOM and surrounding regions aboard the *R.V. Alaminos,* the *R.V. Gyre,* and other research vessels.

Table A-1 gives the names, depth ranges, densities, and identifying features of the remnants of the principal water masses. This table excludes the highly variable surface waters observed in 1) the eastern GOM by Morrison and Nowlin (1977) and Nowlin and McLellan (1967); and 2) the western GOM by Morrison et al. (1983) and Nowlin and McLellan (1967). Water mass property extremes are closely associated with specific density surfaces. All of these subsurface waters derive from outside the Gulf and enter from the Caribbean Sea through the Yucatan Channel. Below about 1,800 m, horizontal distributions of temperature and salinity within the Gulf are essentially uniform (Nowlin, 1972). All of these subsurface waters flow into the Gulf from the Caribbean Sea through the Yucatan Channel. Based on historical observations, horizontal distributions of temperature and salinity within the Gulf are thought to be relatively uniform below the effective sill depth of the Yucatan Channel.

Figure A-3 presents composite plots of temperature vs. salinity, temperature vs. depth, and salinity vs. depth for the winter cruise 62-H-3, which covered the entire Gulf. Evident in these plots is the wide range of near-surface values, especially because sampling extended over the shelves

Summer heating and stratification affect continental-shelf waters in the GOM. Salinity is generally lower nearshore, although fresh water from the Mississippi and other rivers occasionally moves into outer shelf waters. Freshwater intrusions further lower the salinity after local storms.

A.3. METEOROLOGICAL CONDITIONS

The GOM is influenced by a maritime subtropical climate controlled mainly by the clockwise circulation around the semipermanent area of high barometric pressure commonly known as the Bermuda High. The GOM is located to the southwest of this center of circulation. This proximity to the high-pressure system results in a predominantly southeasterly flow in the GOM region. Two important classes of cyclonic storms are occasionally superimposed on this circulation pattern. During the winter months, December through March, cold fronts associated with cold continental air masses influence mainly the northern coastal areas of the GOM. Behind the fronts, strong north winds bring drier air into the region.

Tropical cyclones may develop or migrate into the GOM during the warmer months. These storms may affect any area of the GOM and substantially alter the local wind circulation around them. In coastal areas, the sea breeze effect may become the primary circulation feature during the summer months of May through October. In general, however, the subtropical maritime climate is the dominant feature in driving all aspects of the weather in this region; as a result, the climate shows very little diurnal or seasonal variation.

Selected climatological data for a few selected Gulf coastal locations can be found in **Table A-2**.

The western extension of the Bermuda High dominates the circulation throughout the year, weakening in the winter and strengthening in the summer. The average monthly pressure shows a west to east gradient along the northern Gulf during the summer. In the winter, the monthly pressure is more uniform along the northern Gulf. The minimum average monthly pressure occurs during the summer. The maximum pressure occurs during the winter as a result of the presence and influence of transitional continental cold air.

Average air temperatures at coastal locations vary with latitude and exposure. Air temperature ranges from highs in the summer of 24.7-28.0 ^{o}C to lows in the winter of 2.1-21.7 ^{o}C. Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperatures over the open Gulf exhibit narrower limits of variations on a daily and seasonal basis due to the moderating effect of the large bodies of water. The average temperature over the center of the Gulf is about 29 ^{o}C in the summer and between 17 and 23 ^{o}C in the winter.

The relative humidity over the Gulf is high throughout the year. Minimum humidities occur during the late fall and winter when cold, continental air masses bring dry air into the northern Gulf. Maximum humidities occur during the spring and summer when prevailing southerly winds bring in warm, moist air. The climate in the southwestern GOM is relative dry.

Winds are more variable near the coast than over open waters because coastal winds are more directly influenced by the moving cyclonic storms that are characteristic of the continent and because of the land and sea breeze regime. During the relatively constant summer conditions, the southerly position of the Bermuda High generates predominantly southeasterly winds, which become more southerly in the northern Gulf. Winter winds usually blow from easterly directions with fewer southerlies but more northerlies.

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. Stations along the entire coast record the highest precipitation values during the warmer months of the year. The warmer months usually have convective cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have attendant hail (USDOC, 1967; Brower et al., 1972). The month of maximum rainfall for most locations is July. Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady, and relatively continuous, often lasting several days. Snowfalls are rare, and when frozen precipitation does occur, it usually melts on contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero.

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. Fog occurrence decreases seaward, but visibility has been less than 800 m (2,625 ft) due to offshore fog. Coastal fogs generally last 3-4 hours, although particularly dense sea fogs may persist for several days. The poorest visibility conditions occur during winter and early spring. The period from November through April has the lowest visibility. Industrial pollution and agricultural burning also impact visibilities.

The mixing height is very important because it determines the volume available for dispersing pollutants. Because the mixing height is directly related to vertical mixing in the atmosphere, a mixed layer is expected to occur under neutral and unstable atmospheric conditions. The mixing height tends to be lower in winter, and daily changes are smaller than in summer.

The GOM is part of the Atlantic tropical cyclone basin. Tropical cyclones generally occur in summer and fall seasons; however, the Gulf also experiences winter storms or extratropical storms. These winter storms generally originate in middle and high latitudes and have winds that can attain speeds of 15-26 m/sec (11.2-58.2 mph). The Gulf is an area of cyclone development during cooler months due to the contrast of the warm air over the Gulf and the cold continental air over North America. Cyclogenesis, or the formation of extratropical cyclones, in the GOM is associated with frontal overrunning (Hsu, 1992). The most severe extratropical storms in the Gulf originate when a cold front encounters the subtropical jetstream over the warm waters of the Gulf. Statistics of 100-year data of extratropical cyclones reveal that most activity occurs above 25°N. latitude in the Western GOM. The mean number of these storms ranges from 0.9 near the southern tip of Florida to 4.2 over central Louisiana (Ford et al., 1988).

The frequency of cold fronts in the Gulf exhibits similar patterns during the four-month period of December through March. During this time the area of frontal influence reaches 10° N. latitude. Frontal frequency is about nine fronts per month (1 front every 3 days on the average) in February and about seven fronts per month in March (1 front every 4-5 days on the average). By May, the frequency decreases to about four fronts per month (1 front every 7-8 days) and the region of frontal influence retreats to about 15° N. latitude. During June-August frontal activity decreases to almost zero and fronts seldom reach below 25° N. latitude (Ford et al., 1988).

Tropical cyclones affecting the Gulf originate over the equatorial portions of the Atlantic Ocean, the Caribbean Sea, and the GOM. Tropical cyclones occur most frequently between June and November. Based on 50 years of data, there are about 9.6 storms per year with about 5.9 of those becoming hurricanes in the Atlantic Ocean. Data from 1950 to 2000 show that 79 percent of these storms, or 4.7 storms per year, will affect the GOM (Klotzbach and Gray, 2005). The Yucatan Channel is the main entrance of Atlantic storms into the GOM, and a reduced translation speed over Gulf waters leads to longer residence times in this basin.

There is a high probability that tropical storms will cause damage to physical, economic, biological, and social systems in the Gulf. Tropical storms also affect OCS operations and activities; platform design needs to consider the storm surge, waves, and currents generated by tropical storms. Most of the damage is caused by storm surge, waves, and high winds. Storm surge depends on local factors, such as bottom topography and coastline configuration, and storm intensity. Water depth and storm intensity control wave height during hurricane conditions. Sustained winds for major hurricanes (Saffir-Simpson Category 3 and above) are higher than 49 m/sec (109.6 mph). The Saffir-Simpson scale definitions and a listing for some of the most damaging hurricanes in the Gulf can be found in **Table A-3**.

Recent Hurricanes

During the past few years the Gulf Coast States have been impacted by several major hurricanes. Below is a summary of the National Hurricane Center's (NHC) reports on four of those hurricanes: Hurricanes Lili (2002), Ivan (2004), Katrina (2005), and Rita (2005).

The following information on Hurricane Lili is from the *Tropical Cyclone Report Hurricane Lili 21 September - 04 October 2002* by the NHC (Lawrence, 2003). In 2002, Hurricane Lili reached Category 4 intensity over the GOM. On October 3rd, Hurricane Lili made landfall on the Louisiana coast as a Category 1 hurricane causing widespread wind and flood damage.

The following information on Hurricane Ivan is from *Tropical Cyclone Report Hurricane Ivan 2-24 September 2004* by the NHC (Stewart, 2005). In 2004, Hurricane Ivan reached Category 5 strength in the GOM and weakened slowly before making landfall as a Category 3 hurricane on September 16th just west of Gulf Shores, Alabama. A storm surge of 10-15 ft occurred along the coasts from Destin in the Florida panhandle westward to Mobile Bay/Baldwin County, Alabama. There was also an observed wave height of 52.5 ft reported by a NOAA buoy located in the north-central GOM south of Alabama.

The following information on Hurricane Katrina is from *Tropical Cyclone Report Hurricane Katrina 23-30 August 2005* by the NHC (Knabb et al., 2005). Hurricane Katrina was the costliest and one of the five deadliest hurricanes to ever strike the U.S. and caused a wide swath of catastrophic damage and inflicted large loss of life. The most significant damage and loss of life was inflicted in Louisiana and Mississippi, and significant effects also extended into the Florida panhandle, Georgia, and Alabama. Considering the scope of its impacts, Hurricane Katrina was one of the most devastating natural disasters in U.S. history.

Hurricane Katrina entered the GOM after making landfall in Florida as a Category 1 hurricane. It reached Category 5 intensity over the central GOM and weakened to a Category 3 before making landfall near Buras, Louisiana, and a final landfall near the mouth of the Pearl River at the Louisiana/Mississippi border on August 29, 2005. A buoy located about 64 nmi (74 mi, 119 km) south of Dauphin Island, Alabama, recorded a peak significant wave height of 55 ft.

Data indicate the storm surge from Hurricane Katrina was about 24-28 ft along the Mississippi coast across about 20 mi centered roughly on St. Louis Bay. Along the eastern half of the Mississippi coast

(Gulfport to Pascagoula), the storm surge was 17-22 ft. The storm surge penetrated at least 6 mi inland in many portions of coastal Mississippi and up to 12 mi inland along bays and rivers. In Alabama, the storm surge was 10-15 ft along coastal areas of western Alabama (Mobile County) including Dauphin Island. Flooding occurred several miles inland of Mobile Bay where there was a storm surge of 8-12 ft. The storm surge along the Gulf Coast of eastern Alabama (Baldwin County) was as high as 10 ft.

There was also a significant storm surge west of the path of the eye of Hurricane Katrina. The level of Lake Pontchartain rose; a 12- to 16-ft storm surge pushed several feet of water into the northeastern shore of St. Tammany Parish. A storm surge of 15-19 ft occurred in eastern New Orleans, St. Bernard Parish, and Plaquemines Parish, Louisiana. This storm surge severely strained the levee system in the New Orleans area and several of the levees and floodwalls were overtopped and/or breached. About 80 percent of the city of New Orleans flooded up to 20 ft. The Corps of Engineers reported 43 days after landfall that all floodwaters had been removed from the city of New Orleans.

Less than 1 month after Hurricane Katrina, Hurricane Rita impacted the Gulf Coast States and OCS-related infrastructure. The following information on Hurricane Rita is from the *Tropical Cyclone Report Hurricane Rita 18-26 September 2005* by the NHC (Knabb et al., 2005). Like Hurricane Katrina, Hurricane Rita was an intense hurricane that reached Category 5 strength over the central GOM and weakened prior to making landfall as a Category 3 hurricane near the Texas/Louisiana border.

Also like Hurricane Katrina, Hurricane Rita produced significant storm surge. This storm surge devastated coastal communities in southwestern Louisiana, an area very vulnerable to surge. Unofficial visual estimates suggest that the storm surge was as high as 15 ft in Cameron, Louisiana. Water was also pushed into Calcasieu Lake, flooding portions of communities along its shoreline, such as Grand Lake, with a storm surge of at least 8 ft. The surge then propagated up the Calcasieu River and flooded portions of the Lake Charles area. Flood waters in downtown Lake Charles were as deep as 6 ft. Farther east, most or all of Vermillion, Iberia, and St. Mary Parishes were inundated by the storm surge, visually estimated at 8-12 ft in some of these areas. Hurricane Rita also produced storm surge (4-7 ft) in coastal areas of southeastern Louisiana, flooding some areas that had already been impacted by the surge from Hurricane Katrina. This contributed to prolonging the efforts, which lasted until early October, to remove all floodwaters from the New Orleans area.

A.4. Artificial Reefs and Rigs-to-Reefs Development

Artificial reefs have been used along the coastline of the U.S. since the early nineteenth century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish, but in some instances also enhance the production of fish.

The long-standing debate as to whether artificial reefs contribute to biological production or merely attract the associated marine resources still continues within the scientific arena. The generally accepted conclusion is that artificial reefs both attract and produce fish. This conclusion depends on a variety of factors, such as associated species, limiting environmental factors, fishing pressure, and type of materials used. The degree to which any of the above factors can be controlled will dictate whether any particular artificial reef attract fish or produce fish. In reality, many artificial reefs probably do both attract and produce fish at the same time.

The U.S. Congress passed the National Fishing Enhancement Act (NFEA) in 1984. The NFEA called for the development of a national plan to provide guidance to those individuals, organizations, and agencies interested in artificial reef development and management. The NFEA directed the Secretary of Commerce to develop and publish a long-term National Artificial Reef Plan (NARP) to promote and facilitate responsible and effective use of artificial reefs using the best scientific information available. In 1985, the NOAA's National Marine Fisheries Service (NOAA Fisheries Service) wrote and completed the NARP. The NARP states that properly designed, constructed, and located artificial reefs can enhance the habitat and diversity of fishery resources; enhance U.S. recreational and commercial fishing opportunities; increase the energy efficiency of recreational and commercial fisheries; and contribute to the U.S. coastal economies.

The NARP provides general criteria for selection of materials for artificial reefs. These criteria include: (1) function, which is related to how well a material functions as reef habitat; (2) compatibility, which is related to how compatible a material is with the environment; (3) durability, which is related to how long a material will last in the environment; (4) stability, which is related to how stable a material will be when subject to storms, tides, currents, and other external forces, and (5) availability, which is related to how available a material is to an artificial reef program.

One of the most significant recommendations in the NARP was to encourage the development of State-specific artificial reef plans. The Gulf States Marine Fisheries Commission (GSMFC) and Atlantic States Marine Fisheries Commission (ASMFC) began to coordinate State artificial reef program activities for States along the coast of the GOM and Atlantic Ocean, respectively. Most of the States along the Gulf and Atlantic coasts have taken a leadership role in artificial reef development and management, having developed state-specific plans, and established protocols for siting, deployment, and evaluation of materials for artificial reefs. Each commission formed working committees comprised of State artificial reef program personnel, and representatives from appropriate Federal agencies, including the MMS. Artificial Reef Working Committees of the GSMFC and ASMFC meet jointly to discuss artificial reef issues of a national scope, and separately to discuss issues specific to the Gulf and Atlantic regions. As a result, these committees have been influential in shaping regional and national artificial reef policies and effecting future positive program changes within State and Federal agencies. The working committees have developed guidelines for marine artificial reef materials. The guidelines provide State and Federal agencies and the general public information related to the history, identification of the benefits, drawbacks, and limitations, and use of selected materials for use in the development of marine artificial reefs. The working committees have also produced the document titled "Coastal Artificial Reef Planning Guide." The document reflects the working committee's recommendations to NOAA Fisheries Service for revisions to the National Artificial Reef Plan.

State Artificial Reef Programs

All of the five Gulf Coast States—Texas, Louisiana, Mississippi, Alabama, and Florida—have artificial reef programs and plans. The following are brief descriptions of each State's artificial reef program. The States' artificial reef planning areas, general permit areas, and permitted artificial reef sites within the area of influence considered in this EIS are shown on **Figure A-4**.

Texas

In 1989, the Texas State legislature passed the State's Artificial Reef Act. The Act provided guidance for planning and developing artificial reefs in a cost-effective manner to minimize conflicts and risk to the environment. The Act also directed the Texas Parks and Wildlife Department to promote, develop, maintain, monitor, and enhance the artificial reef potential in State waters and Federal waters adjacent to Texas. The Act defined an artificial reef as a structure constructed, placed, or permitted in the navigable water of Texas or water of the Federal exclusive economic zone adjacent to Texas for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities. To fulfill these purposes, the Department was directed to develop a State artificial reef plan in accordance with Chapter 89 of the Texas Parks and Wildlife code. Texas artificial reefs are mostly retired oil and gas platforms, liberty ships, and military hardware (battle tanks and armored vehicles).

Louisiana

In response to the NFEA, the Louisiana Artificial Reef Initiative (LARI) combined the talents of university, State, Federal, and industry representatives to develop an artificial reef program for the State of Louisiana. As a result, the Louisiana Fishing Enhancement Act (Act 100) became law in 1986. Subsequently, the Louisiana Artificial Reef Plan was written and contains the rationale and guidelines for implementation and maintenance of the State artificial reef program. The State plan is implemented under the leadership of the Louisiana Department of Wildlife and Fisheries. .

The LARI approved nine artificial reef planning areas where artificial reefs can be sited (Kasprzak and Perret, 1996). Artificial reef complexes are established within the planning areas on the basis of the best available information regarding bottom type, currents, bathymetry, and other factors affecting performance and productivity of the reefs. Retired oil and gas platforms are the primary materials that have been use within the Louisiana artificial reef program. Military battle tanks have also been deployed offshore Louisiana for artificial reefs.

Mississippi

Mississippi's artificial reef efforts began in the 1960's. A group consisting primarily of charter boat operators and recreational fishermen obtained funding from their local coastal counties and constructed a car body reef site in the early 1960's. In 1972, the Mississippi Marine Conservation Commission, the organizational predecessor of the current Mississippi Department of Marine Resources, acquired five surplus liberty ships for artificial reefs. This liberty ship project was completed in 1978. The excess funds from the project and the reef permits were transferred to the Mississippi Gulf Fishing Banks, Inc., a private reef building organization made up of conservationists, charter boat operators, and recreational fishermen.

Presently, Mississippi has 47 nearshore, low-profile fishing reefs and 12 offshore reefs. Most of the offshore sites are located within 16-23 km (10-14 mi) from shore. Artificial reef materials used on these sites include liberty ships, rig quarters, tugboats, barges, boxcars, buses, dumpsters, concrete modules, tires, and oil and gas platforms. All of Mississippi's reef sites have active reef permits and suitable material can be deployed at these sites, as they become available (Brainard, 1996).

Alabama

Alabama's artificial reef efforts began in 1953. The first reef project resulted in placement of 250 automobile bodies in water depths of 20-30 m (66-98 ft) offshore Baldwin County. Alabama Department of Conservation and Natural Resources (ADCNR) is the responsible State agency for artificial reef development in State and Federal waters. Alabama's most impressive and lasting contribution to artificial reef activities is the acquisition and placement of five liberty ships in five locations in Alabama's offshore waters, which provide excellent offshore fishing opportunities for recreational fisherman. In 1986 and 1987, the ADCNR was granted by the U.S. Army Corps of Engineers (COE) two artificial reef general permit areas (Don Kelly North and Don Kelly South) offshore Baldwin County. In 1991, a third artificial reef general-permit area (Hugh Swingle) was granted by the COE offshore Mobile County. In 1997, a proposal for extension of the three general permit areas was requested by the ADCNR and permits were issued that year by the COE (Tatum, 1993). Alabama has used a large variety of materials (e.g., shell, concrete, automobile, vehicle tires, aircraft, railroad cars, steel and wooden vessels, oil and gas platforms, and military battle tanks) for reefs in its artificial reef program.

Florida

Florida's first permitted artificial reef site was issued in 1918 (Pybas, 1991). A rapid proliferation of artificial reef sites began in 1980. In the past 25 years, over 300 reef sites were established in State and Federal waters off 34 of Florida's 35 coastal counties on both the Gulf and Atlantic coasts, and more than 2,000 documented artificial reefs have been placed off Florida's coastal counties. Artificial reefs were built at water depths ranging from less than 3 m (10 ft) to greater than 200 m (656 ft). For the past 25 years, Florida's artificial reef program has been a cooperative effort of local governments and State agencies with additional input provided by non-governmental fishing and diving interests. The Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries, manages the State's artificial reef program. The primary objective of the State's program has been to provide grants-in-aid to local coastal governments to develop artificial fishing reefs in State and adjacent Federal waters to increase local sportfishing resources and enhance sportfishing opportunities (Dodrill and Horn, 1996; Maher, 1999). Florida has used a large variety of materials previously mentioned for reefs within their artificial reef program.

Rigs-to-Reefs Development

Rigs-to-Reefs (RTR) is a catchy term for converting obsolete, nonproductive, offshore oil and gas platforms to designated artificial reefs (Dauterive, 2000). Offshore oil and gas platforms began functioning as artificial reefs in 1947 when Kerr-McGee completed the world's first commercially successful oil well in 5.6 m (18 ft) of water, 70 km (44 mi) south of Morgan City, Louisiana. Approximately 4,000 offshore oil and gas platforms exist on the GOM OCS beyond state territorial waters, with most (>90%) occurring offshore the States of Louisiana and Texas. Distribution of offshore platforms across the GOM is presented in **Figure A-5**. Placed with the primary intent of producing oil and/or gas, offshore platforms also provide artificial substrate and marine habitat where natural hard-bottom habitat is at a minimum. These platforms form the largest artificial reef complex in the world (Stanley and Wilson, 2000).

MMS regulations require that platforms be removed within one year after termination of the lease and the platform disposed onshore. Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry but can be a loss of productive marine habitat (Kasprzak and Perret, 1996). The use of obsolete oil and gas platforms for reefs has proven to be highly successful. Their availability, design profile, durability, and stability provide a number of advantages over the use of traditional artificial reef materials. To capture this valuable fish habitat, the States of Louisiana, Texas, and Mississippi in 1986, 1989, and 1999, respectively, passed enabling legislation and signed into law RTR plans for their respective States. Alabama and Florida have no RTR legislation; however, both States have oil and gas platforms in their programs. The distribution of RTR location across the GOM is presented in **Figure A-5**.

The State laws set up a mechanism to transfer ownership and liability of the platform from oil and gas companies to the State when the platform ceases production and the lease is terminated. The company (donor) saves money by donating a platform to the State (recipient) for use as a reef rather than scrapping the platform onshore. The industry then donates 50 percent of the savings to the State to run the State's artificial reef program. Since the inception of the RTR plans, more than 240 retired platforms have been donated and used for reefs offshore of the Gulf Coast States. **Table A-4** shows the RTR donations by State.

A.5. EXISTING OCS-RELATED INFRASTRUCTURE

The numbers below reflect offshore activities in the GOM OCS as of September 2006.

Water Depth	Wells Ever Drilled	Wells Ever Producing
0-60 m	29,975	13,124
60-200 m	11,624	5,502
200-400 m	1,254	576
400-800 m	854	229
800-1,600 m	1,191	277
1,600-2,400 m	353	51
>2,400 m	67	0

Source: USDOI, MMS, 2006b.

Water Depth	Active Leases	Approved Applications to Drill	Active Platforms
0-200 m	3,580	32,187	3,296
200-400 m	223	1,082	21
400-800 m	434	767	10
800-1,000 m	358	407	7
>1,000 m	3,374	1,213	16

Source: USDOI, MMS, 2006b.

Number of Active Platforms by Platform Type

Platform Type	Water Depth					
	0-60 m	60-200 m	200-400 m	400-800 m	800-1,600 m	1,600-2,400 m
Caisson	1,068	3				
Compliant Tower			1	2		
Fixed Leg Platform	1,481	445	20	1		
Mobile Production Unit	2					
Mini Tension Leg Platform				2	2	
Semisubmersible Floating Production System					1	1
Subsea Manifold	1					
Subsea Template		1				
SPAR Platform				2	11	1
Tension Leg Platform				2	8	
Underwater Completion or Subsea Caisson		1				
Well Protector	390	21				

Source: USDOI, MMS, 2006c.

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APPENDIX B

STATE COASTAL ZONE MANAGEMENT PROGRAMS

B. STATE COASTAL ZONE MANAGEMENT PROGRAMS

Each State's CZMP, federally approved by NOAA, is a comprehensive statement setting forth objectives, enforceable policies, and standards for public and private use of land and water resources and uses in that State's coastal zone. The program provides for direct State land and water use planning and regulations. The plan also includes a definition of what constitutes permissible land uses and water uses. Federal consistency is the CZMA requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. The latest Federal consistency regulations concerning State coastal zone management programs are found at 65 *Federal Register* 77123-77154 (December 8, 2000) and 71 *Federal Register* 788-831 (January 5, 2006).

Each Gulf State's official coastal boundary can be identified from NOAA's website at http://coastalmanagement.noaa.gov/mystate/docs/StateCZBoundaries.pdf. Once a State's CZMP is federally approved, Federal agencies must ensure that their actions are consistent to the maximum extent practicable with the enforceable polices of the approved program. Federal agencies provide feedback to the States through each Section 312 evaluation conducted by NOAA.

To ensure conformance with State CZMP policies and local land use plans, MMS prepares a federal consistency determination for each proposed OCS lease sale. Through the designated State CZM agency, local land use entities are provided numerous opportunities to comment on the OCS Program. Local land-use agencies also have the opportunity to comment directly to MMS at any time, as well as during formal public comment periods related to the announcement of the 5-Year Program, Call/NOI, EIS scoping, public hearings on the Draft EIS, and the Proposed Notice of Sale.

A State's approved CZMP may also provide for the State's review OCS plans, permits, and license activities to determine whether they will be conducted in a manner consistent with the State's CZMP. This review authority is applicable to activities conducted in any area that has been leased under the OCSLA and that affect any land or water use or natural resource within the State's coastal zone (16 U.S.C. 1456(c)(3)(B)).

State of Texas Coastal Management Program

The Texas Coastal Management Program (TCMP)/Final EIS was published in August 1996. On December 23, 1996, NOAA approved the TCMP, and the requirements therein were made operational as of January 10, 1997. The TCMP is based primarily on the Coastal Coordination Act (CCA) of 1991 (33 Tex. Nat. Res. Code Ann. Ch. 201, et seq.), as amended by HB 3226 (1995), which calls for the development of a comprehensive coastal program based on existing statutes and regulations. The CCA established the geographic scope of the program by identifying the program's inland, interstate, and seaward boundaries. The program's seaward boundary is the State's territorial seaward limit (3 leagues or 10.36 mi). The State's inland boundary is based on the State's Coastal Facilities Designation Line (CFDL). The CFDL was developed in response to the Oil Spill Act of 1990 and basically delineates those areas within which oil spills could affect coastal waters or resources. For the purposes of the TCMP, the CFDL has been modified to capture wetlands in upper reaches of tidal waters. The geographic scope also extends upstream 200 mi (322 km) from the mouths of rivers draining into coastal bays and estuaries in order to manage water appropriations on those rivers. The program's boundaries encompass all or portions of 18 coastal counties (including Cameron, Willacy, Kenedy, Kleberg, Nueces, San Patricio, Aransas, Refugio, Calhoun, Victoria, Jackson, Matagorda, Brazoria, Galveston, Harris, Chambers, Jefferson, and Orange Counties), roughly 8.9 million ac of land and water.

Within this coastal zone boundary, the scope of the TCMP's regulatory program is focused on the direct management of 16 generic "Areas of Particular Concern," called coastal natural resource areas (CNRA's). These CNRA's are associated with valuable coastal resources or vulnerable or unique coastal areas and include the following: waters of the open GOM; waters under tidal influence; submerged lands; coastal wetlands; seagrasses; tidal sand and mud flats; oyster reefs; hard substrate reefs; coastal barriers; coastal shore areas; GOM beaches; critical dune areas; special hazard areas; critical erosion areas; coastal historic areas; and coastal preserves.

The State has designated the WPA as the geographical area in which Federal consistency shall apply outside of the coastal boundary. The TCMP also identifies Federal lands excluded from the State's coastal zone, such as DOD facilities and wildlife refuges.

Land and water uses subject to the program generally include the siting, construction, and maintenance of electric generating and transmission facilities; oil and gas exploration and production; and the siting, construction, and maintenance of residential, commercial, and industrial development on beaches, critical dune areas, shorelines, and within or adjacent to critical areas and other CNRA's. Associated activities also subject to the program include canal dredging; filling; placement of structures for shoreline access and shoreline protection; on-site sewage disposal, storm-water control, and waste management for local governments and municipalities; the siting, construction, and maintenance of public buildings and public works such as dams, reservoirs, flood control projects and associated activities; the siting, construction, and maintenance of roads, highways, bridges, causeways, airports, railroads, and nonenergy transmission lines and associated activities; certain agricultural and silvicultural activities; water impoundments and diversions; and the siting, construction, and maintenance of marinas, State-owned fishing cabins, artificial reefs, public recreational facilities, structures for shoreline access and shoreline protection, boat ramps, and fishery management measures in the Gulf.

The TCMP is a networked program that is implemented primarily through 8 State agencies, 18 local governments, and the Coastal Coordination Council (Council). The program relies primarily on direct State control of land and water uses, although local governments will implement State guidelines related to beach and dune management. Implementation and enforcement of the coastal policies is primarily the responsibility of the networked agencies and local governments through their existing statutes, regulatory programs, or other authorizations. Networked agencies include the General Land Office/School Land Board, Texas Commission on Environmental Quality, Railroad Commission of Texas, Parks and Wildlife Commission, Texas Transportation Commission, Texas Historical Commission, the Public Utility Commission, the Texas State Soil and Water Conservation Board, and the Texas Water Development Board. In addition, the Texas Sea Grant College Program is a nonvoting member of the Council. Other members on the Council include four gubernatorial appointees: a coastal business representative, a agriculture representative, a local elected official, and a coastal citizen. Similarly, 18 county and municipal governments, in those counties with barrier islands, are also networked entities with responsibilities for program implementation vis-a-vis beaches and dunes.

Local land uses and government entities are linked to the management of Texas CNRA's in the TCMP. Local governments are notified of relevant TCMP decisions, including those that may conflict with local land-use plans or zoning ordinances. The Coastal Coordination Council includes a local government representative as a full-voting member. An additional local government representative can be added to the Council as a nonvoting member for special local matters under review. The Council will establish a permanent advisory committee to ensure effective communication for local governments with land-use authority.

In 1994, MMS entered into a Memorandum of Understanding (MOU) with the Texas General Land Office to address similar mineral resource management responsibilities between the two entities and to encourage cooperative efforts and promote consistent regulatory practices. This MOU, which encompasses a broad range of issues and processes, outlines the responsibilities and cooperative efforts, including leasing and CZMA review processes, agreed to by the respective agencies. Effective January 10, 1997, all operators were required to submit to MMS certificates of consistency with the TCMP for proposed operations in the WPA.

The MMS developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. Western GOM Lease Sale 168 was the first MMS Federal action subject to State consistency review. The MMS and the State of Texas revised CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2006-G14 and 2006-G15). The State of Texas requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a federal consistency certification, assessment, and findings. The State's requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR Part 250, 30 CFR Part 254, 30 CFR 250 Part 256, and NOAA's Federal consistency regulations at 15 CFR Part 930. The MMS will be continuing a dialogue with the State of Texas on reasonably foreseeable coastal effects for pipelines and other permits, and the result of these discussions will be incorporated into future updates of MMS's NTL's and/permitting procedures.

State of Louisiana Coastal Resources Program

The statutory authority for Louisiana's coastal zone management program, the Louisiana Coastal Resources Program (LCRP), is the State and Local Coastal Resources Management Act of 1978, *et seq*. (Louisiana Administrative Code, Vol. 17, Title 43, Chapter 7, Coastal Management, June 1990 revised). The State statute puts into effect a set of State coastal policies and coastal use guidelines that apply to coastal land and water use decisionmaking. A number of existing State regulations are also incorporated into the program including those concerning oil and gas and other mineral operations; leasing of State lands for mineral operations and other purposes; hazardous waste and radioactive materials; management of wildlife, fish, other aquatic life, and oyster beds; endangered species; air and water quality; and the Louisiana Superport.

The State statute also authorized establishment of Special Management Areas. Included or planned to be included as Special Management Areas are LOOP and Marsh Island. For purposes of the CZMA, only that portion of LOOP within Louisiana's coastal zone is part of the Special Management Area. In April 1989, the Louisiana Legislature created the Wetlands Conservation and Restoration Authority and established a Wetlands Conservation and Restoration Trust Fund to underwrite restoration projects. The Legislature also reorganized part of the Louisiana Department of Natural Resources (LDNR, LADNR) by creating the Office of Coastal Restoration and Management.

Local governments (parishes) may assume management of uses of local concern by developing a local coastal program consistent with the State CZM plan. The State of Louisiana has 11 approved local coastal management programs (Calcasieu, Cameron, Jefferson, Lafourche, Orleans, St. Bernard, St. James, St. John the Baptist, Plaquemines, Terrebonne, and St. Tammany Parishes). Eight other programs (Assumption, Iberia, Livingston, St. Charles, St. Martin, St. Mary, Tangipahoa, and Vermilion Parishes) have not been formally approved by NOAA. The parish planning and/or permits offices often serve as the permitting agency for projects limited to local concern. Parish-level programs, in addition to issuing permits for uses of local concern, also function as a commenting agency to Louisiana's CZM agency, the Coastal Management Division, regarding permitting of uses of State concern.

Appendix C2 of the LCRP outlines the rules and procedures for the State's local coastal management programs. Under the LCRP, parishes are authorized, though not required, to develop local coastal management programs. Approval of these programs gives parishes greater authority in regulating coastal development projects that entail uses of local concern. Priorities, objectives, and policies of local land use plans must be consistent with the policies and objectives of Act 361, the LCRP, and the State guidelines, except for a variance adopted in Section IV.D. of Appendix C2 of the LCRP. The Secretaries of DNR and Wildlife and Fisheries may jointly rule on an inconsistent local program based on local environmental conditions or user practices. State and Federal agencies review parish programs before they are adopted.

The coastal use guidelines are based on seven general policies. State concerns that could be relevant to an OCS lease sale and its possible direct effects or associated facilities and nonassociated facilities are (a) any dredge and fill activity that intersects more than one water body, (b) projects involving the use of State-owned lands or water bottoms, (c) national interest projects, (d) pipelines, and (e) energy facility siting and development. Some coastal activities of concern that could be relevant to a lease sale include wetland loss due to channel erosion from OCS traffic; activities near reefs and topographic highs; activities that might affect endangered, threatened, or commercially valuable wildlife; and potential socioeconomic impacts due to offshore development. Secondary and cumulative impacts to coastal resources such as onshore facility development, cumulative impacts from infrastructure development, salt intrusion along navigation channels, etc. are also of particular concern.

Effective August 1993, the DNR Coastal Management Division required that any entity applying for permits to conduct activities along the coast must notify the landowner of the proposed activity. An affidavit must also accompany any permit application. Through this regulation, the State strives to minimize coastal zone conflicts.

The MMS and the State of Louisiana revised CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2006-G14 and 2006-G15). Federal consistency for ROW pipelines is addressed in NTL 2002 G-15. The State of Louisiana requires an adequate description, objective, and schedule for the project. Also, the State requires site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges (including any disposal of wastes within the State coastal zone and waters and municipal, parish, or State facilities to be used), transportation activities, air emissions, and secondary and cumulative impacts; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.mms.gov/homepg/regulate/regs/ntls/enforpols.pdf. The State requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR Part 250, 30 CFR Part 254, 30 CFR Part 256, and NOAA's Federal consistency regulations at 15 CFR Part 930. The MMS is continuing a dialogue with the State of Louisiana on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of MMS's NTL's and/or permitting procedures.

State of Mississippi Coastal Program

The Mississippi Coastal Program (MCP) is administered by the Mississippi Department of Marine Resources. The MCP is built around 10 enforceable goals that promote comprehensive management of coastal resources and encourage a balance between environmental protection/preservation and development in the coastal zone. The primary coastal management statute is the Coastal Wetlands Protection Law. Other major features of the MCP include statutes related to fisheries, air and water pollution control, surface and groundwater, cultural resources, and the disposal of solid waste in marine waters. The Department of Marine Resources, the Department of Environmental Quality, and the Department of Archives and History are identified collectively as the "coastal program agencies." Mississippi manages coastal resources by regulation and by promoting activities that use resources in compliance with the MCP. The State developed a coastal wetlands use plan, which includes designated use districts in coastal wetlands and Special Management Area Plans that steer development away from fragile coastal resources and help to resolve user conflicts.

For the purposes of the coastal program, the coastal zone encompasses the three coastal counties of Hancock, Harrison, and Jackson and all coastal waters. The Mississippi coast has 369 mi (594 km) of shoreline, including the coastlines of offshore barrier islands (Cat, Ship, Horn, and Petit Bois Islands). According to NOAA, there are no approved local coastal management plans for the State of Mississippi. The Southern Mississippi Planning and Development District serves in an advisory capacity to the State coastal agencies.

The MMS developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. The MMS and the State of Mississippi revised CZM consistency information for OCS plans, permits and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2006-G14 and 2006-G15). Federal consistency for ROW pipelines is addressed in NTL 2002 G-15. The State of Mississippi requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.mms.gov/homepg/regulate/regs/ntls/enforpols.pdf. The State requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR Part 250, 30 CFR Part 254, 30 CFR Part 256, and NOAA's Federal consistency requirements at 15 CFR Part 930. The MMS is continuing a dialogue with the State of Mississippi on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of MMS's NTL's and/or permitting procedures.

State of Alabama Coastal Area Management Program

The Alabama Coastal Area Act (ACAA) provides statutory authority to review all coastal resource uses and activities that have a direct and significant effect on the coastal area. The Alabama Department of Conservation and Natural Resources (ADCNR) Lands Division, Coastal Section Office, the lead coastal management agency, is responsible for the management of the State's coastal resources through the Alabama Coastal Area Management Program (ACAMP). The ADCNR is responsible for the overall management of the program including fiscal and grants management and public education and information. The department also provides planning and technical assistance to local governments and financial assistance to research facilities and units of local government when appropriate. The State Lands Division, Coastal Section, also has authority over submerged lands in regard to piers, marinas, bulkheads, and submerged land leases.

The Alabama Department of Environmental Management (ADEM) is responsible for coastal area permitting, regulatory and enforcement functions. Most programs of ADCNR Coastal Section that require environmental permits or enforcement functions are carried out by the ADEM with the exception of submerged land issues. The ADEM has the responsibility of all permit, enforcement, regulatory, and monitoring activities, and the adoption of rules and regulations to carry out the ACAMP. The ADEM must identify specific uses or activities that require a State permit to be consistent with the coastal policies noted above and the more detailed rules and regulations promulgated as part of the ACAMP. Under the ACAA, State agency activities must be consistent with ACAMP policies and ADEM findings. Further, ADEM must make a direct permit-type review for uses that are not otherwise regulated at the State level. The ADEM also has authority to review local government actions and to assure that local governments do not unreasonably restrict or exclude uses of regional benefit. Ports and major energy facilities are designated as uses of regional benefit. The ADCNR Lands Division manages all lease sales of State, submerged bottomlands and regulates structures placed on State, submerged bottomlands.

Local governments have the option to participate in the ACAMP by developing local codes, regulations, rules, ordinances, plans, maps, or any other device used to issue permits or licenses. If these instruments are certified to be consistent with ACAMP, ADEM may allow the local government to administer them by delegating its permit authority, thereby eliminating the need for ADEM's case-by-case review.

The South Alabama Regional Planning Commission provides ongoing technical assistance to ADCNR for Federal consistency, clearinghouse review, and public participation procedures. Uses subject to the Alabama's CZMP are divided into regulated and nonregulated categories. Regulated uses are those that have a direct and significant impact on the coastal areas. These uses either require a State permit or are required by Federal law to be consistent with the management program. Uses that require a State permit must receive a certificate of compliance. Nonregulated uses are those activities that have a direct and significant impact on the coastal areas that do not require a State permit or Federal consistency certification. Nonregulated uses must be consistent with ACAMP and require local permits to be administered by ADEM.

The MMS developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. The MMS and the State of Alabama have revised CZM consistency information for OCS plans, permits and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2006-G14 and 2006-G15). Federal consistency for ROW pipelines is addressed in NTL 2002 G-15. The State of Alabama requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.mms.gov/homepg/regulate/regs/ntls/enforpols.pdf. The State's requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR Part 250, 30 CFR Part 254, 30 CFR Part 256, and NOAA's Federal consistency requirements at 15 CFR Part 930. The MMS is continuing a dialogue with the State of Alabama on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of MMS's NTL's and/or permitting procedures.

State of Florida Coastal Management Program

For purposes of the CZMA, the State of Florida's coastal zone includes the area encompassed by the State's 67 counties and its territorial seas. Lands owned by the Federal Government and the Seminole and Miccosukee Indian tribes are not included in the State's coastal zone; however, Federal activities in or outside the coastal zone, including those on Federal or tribal lands, that affect any land or water or natural resource of the State's coastal zone are subject to review by Florida under the CZMA. The Florida Coastal Management Act, codified as Chapter 380, Part II, Florida Statutes, authorized the development of a coastal management program. In 1981 the Florida Coastal Management Program (FCMP) was approved by NOAA.

The policies identified by the State of Florida as being enforceable in the FCMP are the 23 chapters that NOAA approved for incorporation in the State's program. The 2005 Florida Statutes are the most recent version approved by NOAA and include the listing of OCSLA permits under Subpart E; and the addition of draft EA's and EIS's as necessary data and information for Federal consistency review

A network of eight State agencies and five regional water management districts implement the FCMP's 23 statutes. The water management districts are responsible for water quantity and quality throughout the State's watersheds. The State agencies include the following: the Department of Environmental Protection, the lead agency for the FCMP and the State's chief environmental regulatory agency and steward of its natural resources; the Department of Community Affairs, which serves as the State's land planning and emergency management agency; the Department of Health, which, among other responsibilities, regulates on-site sewage disposal; the Department of State, Division of Historical Resources, which protects historic and archaeological resources; the Fish and Wildlife Conservation Commission, which protects and regulates fresh and saltwater fisheries, marine mammals, and birds and upland species, including protected species and the habitat used by these species; the Department of Transportation, which is charged with the development, maintenance, and protection of the transportation system; the Department of Agriculture and Consumer Services, which manages State forests and administers aquaculture and mosquito control programs; and the Governor's Office of Planning and Budget, which plays a role in the comprehensive planning process.

Effective July 1, 2000, the Governor of Florida assigned the State's responsibilities under the Outer Continental Shelf Lands Act (43 U.S.C.) to the Secretary of the Florida Department of Environmental Protection (DEP). The DEP's Office of Intergovernmental Programs coordinates the review of OCS plans with FCMP member agencies to ensure that the plan is consistent with applicable State enforceable policies and the Governor's responsibilities under the Act.

The MMS developed coordination procedures with the State for the submittal of offshore lease sale consistency determinations and plans of operation. In 2003, MMS and the State revised CZM consistency information for OCS plans, permits, and licenses to conform with the revised CZM regulations that were effective on January 8, 2001, and updated on January 5, 2006, and they have also incorporated streamlining improvements into the latest NTL's (NTL's 2006-G14 and 2006-G15). Federal consistency for ROW pipelines is addressed in NTL 2002 G-15.

The State of Florida requires an adequate description, objective, and schedule for all activities associated with a project; specific information on the natural resources potentially affected by the proposed activities; and specific information on onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. As identified by the State of Florida, the State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.mms.gov/homepg/regulate/regs/ntls/enforpols.pdf. These requirements have been incorporated into the Plans and Regional Oil-Spill Response NTL's. The State requirements for Federal consistency review are based on the requirements of State statutes, CZMA regulations at 15 CFR Part 930, and DOI's regulations at 30 CFR Part 250, 30 CFR Part 254, and 30 CFR Part 256. The MMS is continuing a dialog with the State of Florida on reasonably foreseeable coastal effects associated with OCS plans, pipelines, and other permits; the result of these discussions will be incorporated into future updates of MMS's NTL's and/or permitting procedures.

APPENDIX C

RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO REGION, 2003-PRESENT

C. RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO REGION, 2003 TO PRESENT

Published in 2006	
Study Number	Title
MMS 2006-005	*Fidelity of Red Snapper to Petroleum Platforms and Artificial Reefs in the Northern Gulf of Mexico*
MMS 2006-011	*Sustainable Community in Oil and Gas Country: Final Report*
MMS 2006-028	*Degradation of Synthetic-Based Drilling Mud Base Fluids by Gulf of Mexico Sediments, Final Report*
MMS 2006-030	*Accounting for Socioeconomic Change from Offshore Oil and Gas: Cumulative Effects on Louisiana's Coastal Parishes, 1969-2000*
MMS 2006-034	*Sperm Whale Seismic Study in the Gulf of Mexico, Summary Report: 2002-2004*
MMS 2006-035	*Long-Term Monitoring at the East and West Flower Garden Banks National Marine Sanctuary, 2002-2003*
MMS 2006-036	*Study to Conduct National Register of Historic Places Evaluations of Submerged Sites on the Gulf of Mexico Outer Continental Shelf*
MMS 2006-037	*Effect of Depth, Location, and Habitat Type, on Relative Abundance and Species Composition of Fishes Associated with Petroleum Platforms and Sonnier Bank in the Northern Gulf of Mexico*
	Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico;
MMS 2006-044	*Volume I: Executive Summary*
MMS 2006-045	*Volume II: Technical Report*
MMS 2006-046	*Volume III: Appendices*

Published in 2005	
Study Number	Title
MMS 2005-008	*Visibility and Atmospheric Dispersion Capability over the Northern Gulf of Mexico: Estimates and Observations of Boundary Layer Parameters*
MMS 2005-009	*Interactions Between Migrating Birds and Offshore Oil and Gas Platforms in the Northern Gulf of Mexico: Final Report*
MMS 2005-012	*Potential Spatial and Temporal Vulnerability of Pelagic Fish Assemblages in the Gulf of Mexico to Surface Oil Spills Associated with Deepwater Petroleum Development*
MMS 2005-016	*Workshop on Socioeconomic Research Issues for the Gulf of Mexico OCS Region, February 2004*
MMS 2005-019	*Effects of Oil and Gas Development: A Current Awareness Bibliography 2000-2004*
MMS 2005-029	*Modeling Structure Removal Processes in the Gulf of Mexico*
MMS 2005-031	*Climatology of Ocean Features in the Gulf of Mexico*
MMS 2005-032	*Understanding the Processes that Maintain the Oxygen Levels in the Deep Gulf of Mexico: Synthesis Report*
MMS 2005-038	*Characterization of Algal-Invertebrate Mats at Offshore Platforms and the Assessment of Methods for Artificial Substrate Studies*

MMS 2005-039	*Aspects of the Louisiana Coastal Current*
MMS 2005-044	*Relative Contribution of Produced Water Discharge Oxygen Demand in the Development of Hypoxia*
MMS 2005-054	*Evaluating Sublethal Effects of Exposure to Petroleum Additives on Fishes Associated with Offshore Platforms*
MMS 2005-066	*Proceedings: Twenty-Third Gulf of Mexico Information Transfer Meeting, January 2005*
MMS 2005-067	*Mapping Areas of Hard Bottom and Other Important Bottom Types: Outer Continental Shelf and Upper Continental Slope*

Published in 2004	
Study Number	Title
Executive Summary	*Gulf of Mexico Comprehensive Synthetic Based Muds Monitoring Program* *Volume I* *Volume II* *Volume III - Appendices*
MMS 2004-009	*Long-Term Oil and Gas Structure Installation and Removal Forecasting in the Gulf of Mexico: A Decision- and Resource-Based Approach*
MMS 2004-013	*Intermediate Depth Circulation in the Gulf of Mexico: PALACE Float Results for the Gulf of Mexico Between April 1998 and March 2002*
MMS 2004-015	*Minerals Management Service Environmental Studies Program: A History of Biological Investigations in the Gulf of Mexico, 1973-2000*
MMS 2004-016	*Fiscal System Analysis: Concessionary and Contractual Systems Used in Offshore Petroleum Arrangements*
MMS 2004-017	*Cross-Shelf Exchange Processes and the Deepwater Circulation of the Gulf of Mexico: Dynamical Effects of Submarine Canyons and Interactions of Loop Current Eddies with Topography; Final Report*
MMS 2004-022	*Subsurface, High-Speed Current Jets in the Deepwater Region of the Gulf of Mexico: Final Report*
MMS 2004-027	*OCS-Related Infrastructure in the Gulf of Mexico Fact Book*
MMS 2004-036	*Observational and Predictive Study of Inner Shelf Currents over the Louisiana-Texas Shelf*
MMS 2004-040	*Strong Mid-Depth Currents and a Deep Cyclonic Gyre in the Gulf of Mexico*
MMS 2004-041	*Economic Impact in the U.S. of Deepwater Projects: A Survey of Five Projects*
MMS 2004-047	*Supply Network for Deepwater Oil and Gas Development in the Gulf of Mexico: An Empirical Analysis of Demand for Port Services*
MMS 2004-049 MMS 2004-050 MMS 2004-051	*History of the Offshore Oil and Gas Industry in Southern Louisiana: Interim Report* *Volume I: Papers on the Evolving Offshore Industry* *Volume II: Bayou Lafourche – An Oral History of the Development of the Oil and Gas Industry* *Volume III: Samples of Interviews and Ethnographic Prefaces*
MMS 2004-052	*Effects of Changes in Oil and Gas Prices and State Offshore Petroleum Production on the Louisiana Economy, 1969-1999*
MMS 2004-057	*Labor Migration and the Deepwater Oil Industry*
MMS 2004-060	*Boundary Layer Study in the Western and Central Gulf of Mexico*

MMS 2004-063	*High-Resolution Integrated Hydrology-Hydrodynamic Model: Development and Application to Barataria Basin, Louisiana*
MMS 2004-067	*Sperm Whale Seismic Study in the Gulf of Mexico; Annual Report: Year 2*
MMS 2004-070	*User's Guide for the 2005 Gulfwide Offshore Activities Data System (GOADS-2005): Final Report*
MMS 2004-071	*Data Quality Control and Emissions Inventories of OCS Oil and Gas Production Activities in the Breton Area of the Gulf of Mexico*
MMS 2004-072	*Gulfwide Emission Inventory for the Regional Haze and Ozone Modeling Effort*

Published in 2004	
Study Number	Title
MMS 2003-004	*Dynamics of the Oil and Gas Industry in the Gulf of Mexico: 1980-2000; Final Report*
MMS 2003-005	*Proceedings: Twenty-First Annual Gulf of Mexico Information Transfer Meeting, January 2002*
MMS 2003-009	*Rigs and Reefs: A Comparison of the Fish Communities at Two Artificial Reefs, a Production Platform, and a Natural Reef in the Northern Gulf of Mexico*
MMS 2003-018	*Modeling the Economic Impacts of Offshore Oil and Gas Activities in the Gulf of Mexico: Methods and Applications*
MMS 2003-022	*Labor Demand in the Offshore Oil and Gas Industry in the 1990s: The Louisiana Case*
MMS 2003-029	*Importance of Zooplankton in the Diets of Blue Runner (Caranx crysos) Near Offshore Petroleum Platforms in the Northern GOM*
MMS 2003-030	*Workshop on Deepwater Environmental Studies Strategy: A Five-Year Follow-Up and Planning for the Future*
MMS 2003-031	*Long-Term Monitoring of the East and West Flower Garden Banks National Marine Sanctuary, 2000-2001*
MMS 2003-038	*Environmental Justice Considerations in Lafourche Parish, Louisiana*
MMS 2003-040	*Marine and Coastal Fishes Subject to Impingement by Cooling-Water Intake Systems in the Northern Gulf of Mexico: An Annotated Bibliography*
MMS 2003-041	*Changing Patterns of Ownership and Control in the Petroleum Industry: Implications for the Market for Oil and Gas Leases in the Gulf of Mexico OCS Region, 1983-1999*
  MMS 2003-048 MMS 2003-049	*Deepwater Observations in the Northern Gulf of Mexico from In-Situ Current Meters and PIES: Final Report* *Volume I: Executive Summary* *Volume II: Technical Report*
  MMS 2003-060 MMS 2003-061 MMS 2003-062	*Refining and Revising the GOM OCS Region High-Probability Model for Historic Shipwrecks* *Volume I: Executive Summary* *Volume II: Technical Narrative* *Volume III: Appendices*
MMS 2003-063	*Historical Reconstruction of the Contaminant Loading and Biological Responses in the Central Gulf of Mexico Shelf Sediments*
MMS 2003-065	*Preparation of an Interactive Key for Northern Gulf of Mexico Polychaete Taxonomy Employing the DELTA/INTKEY System*
MMS 2003-069	*Sperm Whale Seismic Study in the Gulf of Mexico; Annual Report: Year 1*
MMS 2003-070	*Explosive Removal of Offshore Structures: Information Synthesis Report*

MMS 2003-072	*Selected Aspects of the Ecology of the Continental Slope Fauna of the Gulf of Mexico: A Synopsis of the Northern Gulf of Mexico Continental Slope Study, 1983-1988*
MMS 2003-073	*Proceedings: Twenty-Second Annual Gulf of Mexico Information Transfer Meeting*
MMS 2003-074	*Modeling and Data Analysis of Circulation Processes in the Gulf of Mexico: Final Report*

APPENDIX D
COOPERATING AGENCY

ORD

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

JUL 14 2006

Mr. Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico Region
1200 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Dear Mr. Oynes:

We are pleased to forward the Memorandum of Understanding (MOU) between our agencies. This MOU outlines the responsibilities of MMS and EPA with respect to the preparation of the Multisale Environmental Impact Statement for the Gulf of Mexico Central and Western Planning Areas (2007-2012).

The MOU is consistent with the long standing partnership our agencies have maintained and will help guide our staffs as they work together on this important project. Two copies of the MOU are enclosed. Please sign and return one copy to me so that each of our agencies will have an original signed copy.

We also appreciate your inviting the EPA to be a cooperating agency in this effort. If I may be of further assistance, please give me a call at (214) 665-2100 or have your staff contact Mr. Scott Wilson of my staff at (214) 665-7511.

Sincerely yours,

Richard E. Greene
Regional Administrator

Enclosures (2)

Memorandum of Understanding between
The Minerals Management Services, Gulf of Mexico OCS Region
and the U. S. Environmental Protection Agency, Region 6, for Preparation of
the Multisale Environmental Impact Statement, Gulf of Mexico, Central and Western
Planning Areas, 2007-2012

INTRODUCTION

The Minerals Management Service (MMS) prepares Environmental Impact Statements (EIS) to assess the consequences of the proposed oil and gas lease sales on the Outer Continental Shelf (OCS). The MMS's EIS preparation process complies with the provisions of the National Environmental Policy Act (NEPA) as detailed in the Council for Environmental Quality's (CEQ) regulations 40 CFR 1500.

The U.S. Environmental Protection Agency (EPA) has authority under the Clean Water Act (CWA) Section 402 to issue National Pollutant Discharge Elimination System (NPDES) permits to regulate discharges to waters of the United States. Section 306 and 40 CFR 122.29 of the CWA require that a NEPA document be prepared when EPA issues an NPDES permit to a new source. EPA also has jurisdiction over air quality in the Gulf of Mexico OCS, east of 87.5°W. longitude.

Section 1501.6 of the CEQ's regulations emphasizes agency cooperation in the NEPA process between federal agencies either having overlapping jurisdiction or special expertise related to a proposed action. The March 31, 1984, Memorandum of Understanding (MOU) between EPA and the Department of the Interior outlines provisions for the coordination of NPDES permits issuance with lease offerings and NEPA responsibilities.

The MMS is preparing a multisale EIS for 11 proposed sales in the 5-Year Program for 2007-2012: 6 sales in the Central Planning Area (205, 206, 208, 213, 216, and 222) and 5 sales in the Western Planning Area (204, 207, 210, 215, and 218). EPA has requested to be a cooperating agency on this EIS.

This MOU outlines the responsibilities agreed to by MMS and EPA with respect to preparation of this EIS.

This MOU does not affect EPA's independent review responsibilities under Section 309 of the Clean Air Act. EPA will conduct an official Section 309 review on all appropriate sections of the EIS. This MOU does not affect MMS's responsibilities under the OCS Lands Act and regulations under 30 CFR 250.

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MMS RESPONSIBILITIES

MMS is the lead agency for preparation of the EIS.

MMS will designate a primary point of contact for matters related to the MOU.

MMS will have the lead in setting up and holding public hearings for the draft EIS.

MMS will provide EPA copies or a summary of all comments received during preparation of the EIS, including comments received during the scoping process, public meetings/hearings, and circulation of the EIS.

MMS will place a copy of the MOU in an appendix to the EIS.

MMS will provide EPA with early versions of the EIS sections dealing with water quality and air quality.

MMS will provide EPA with a preliminary copy of the EIS for review prior to final lead agency approval and distribution of the document.

EPA RESPONSIBILITIES

EPA is a cooperating agency for preparation of the EIS.

EPA will designate a primary point of contact to represent EPA in matters related to this MOU.

EPA will participate, as they deem appropriate, in the public hearing process.

EPA will provide MMS a brief description of EPA's cooperating status to be placed in the EIS. The description will define the agency's cooperating status and summarize the reasons EPA is a cooperating agency for the EIS.

The comments provided by EPA to MMS are advisory.

During EPA's participation in the review and comment process, EPA will comply with the EIS preparation schedule for the MMS.

EPA will be responsible for any expenses incurred by EPA related to this MOU.

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TERMINATION

The MOU may be terminated by written notice by either of the below signatories at any time.

LIMITATIONS

All commitments made in the MOU are subject to the availability of appropriated funds and each agency's budget priorities. Nothing in the MOU obligates MMS or EPA to expend appropriations or to enter into any contract, assistance agreement, interagency agreement, or incur other financial obligations.

This MOU is neither a fiscal nor a funds obligation document. Any endeavor involving reimbursement or contribution of funds between the parties to this MOU will be handled in accordance with applicable laws, regulations, and procedures, and will be subject to separate subsidiary agreements that will be effected in writing by representatives of both parties.

This MOU does not create any right or benefit enforceable against the MMS or EPA, their officers or employees, or any other person. This MOU does not apply to any person outside MMS and EPA.

Chris C. Oynes

Date: 7-25-06

Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region

Richard E. Greene

Date: 07-14-06

Richard E. Greene
Regional Administrator
U.S. Environmental Protection Agency
Region 6

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.