OCS EIS/EA
BOEM 2014-010

Gulf of Mexico OCS
Oil and Gas Lease Sales: 2015-2017

Central Planning Area Lease Sales 235, 241, and 247

Draft Supplemental Environmental Impact Statement

U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

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REGIONAL DIRECTOR'S NOTE

This Supplemental Environmental Impact Statement (EIS) addresses three proposed Federal actions: proposed Outer Continental Shelf (OCS) oil and gas Lease Sales 235, 241, and 247 in the Central Planning Area (CPA) of the Gulf of Mexico, as scheduled in the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017* (Five-Year Program) (USDOI, BOEM, 2012a). This Supplemental EIS incorporates by reference all of the relevant material in the EIS's from which it tiers: *Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247, Final Environmental Impact Statement* (2012-2017 WPA/CPA Multisale EIS) (USDOI, BOEM, 2012b); and *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement* (WPA 233/CPA 231 Supplemental EIS) (USDOI, BOEM, 2013a).

The 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS analyzed the potential impacts of a CPA proposed action on the marine, coastal, and human environments. It is important to note that the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS were prepared using the best information that was publicly available at the time the documents were prepared. This Supplemental EIS is deemed appropriate to supplement the documents cited above for proposed CPA Lease Sales 235, 241, and 247 in order to consider new circumstances and information arising from, among other things, the *Deepwater Horizon* explosion, oil spill, and response. This Supplemental EIS's analysis focuses on updating the baseline conditions and potential environmental effects of oil and natural gas leasing, exploration, development, and production in the CPA since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. This Supplemental EIS will also assist decisionmakers in making informed, future decisions regarding the approval of operations, as well as leasing. This Supplemental EIS is the final National Environmental Policy Act (NEPA) review conducted for proposed CPA Lease Sale 235. A separate NEPA review will be conducted prior to proposed CPA Lease Sales 241 and 247 to address any newly available significant information relevant to those proposed actions.

BOEM's Gulf of Mexico OCS Region and its predecessors have been conducting environmental analyses of the effects of OCS oil and gas development since the inception of the NEPA. We have prepared and published more than 50 draft and 50 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.

John L. Rodi
Regional Director
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

COVER SHEET

Supplemental Environmental Impact Statement
for
Proposed OCS Oil and Gas Lease Sales 235, 241, and 247
in the Central Planning Area of the Gulf of Mexico

Draft (x) **Final ( )**

Type of Action: Administrative (x) Legislative ( )

Area of Potential Impact: Offshore Marine Environment and Coastal Counties/Parishes of Louisiana, Mississippi, Alabama, and northwestern Florida

Agency	Headquarters Contact	Region Contacts
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ABSTRACT

This Supplemental Environmental Impact Statement (EIS) addresses three proposed Federal actions: proposed Outer Continental Shelf (OCS) oil and gas Lease Sales 235, 241, and 247 in the Central Planning Area (CPA) of the Gulf of Mexico, as scheduled in the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017* (Five-Year Program) (USDOI, BOEM, 2012a).

This Supplemental EIS updates the baseline conditions and potential environmental effects of oil and natural gas leasing, exploration, development, and production in the CPA since publication of *Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247, Final Environmental Impact Statement* (2012-2017 WPA/CPA Multisale EIS) (USDOI, BOEM, 2012b) and *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement* (WPA 233/CPA 231 Supplemental EIS) (USDOI, BOEM, 2013a). This Supplemental EIS analyzes the potential impacts of a CPA proposed action on sensitive coastal environments, offshore marine resources, and socioeconomic resources both onshore and offshore. It is important to note that this Supplemental EIS was prepared using the best information that was publicly available at the time the document was prepared. Where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives and if so, it was either acquired or in the event it was impossible or exorbitant to acquire the information, accepted scientific methodologies were applied in its place.

The proposed actions are considered to be major Federal actions requiring an EIS. This document provides the following information in accordance with the National Environmental Policy Act (NEPA) and its implementing regulations, and it will be used in making decisions on the proposal. This Supplemental EIS is the final NEPA review conducted for proposed CPA Lease Sale 235. A separate NEPA review will be conducted prior to BOEM's decision on whether or how to proceed with proposed CPA Lease Sales 241 and 247. This document includes the purpose of and need for a CPA proposed

action, identification of the alternatives, description of the affected environment, and an analysis of the potential environmental impacts of a CPA proposed action, 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 CPA proposed action is adopted. Activities and disturbances associated with a CPA proposed action on biological, physical, and socioeconomic resources are considered in the analyses.

Additional copies of this Supplemental EIS, the 2012-2017 WPA/CPA Multisale EIS, the WPA 233/CPA 231 Supplemental EIS, and the other referenced publications may be obtained from the Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, Public Information Office (GM 335A), 1201 Elmwood Park Boulevard, Room 250, New Orleans, Louisiana 70123-2394, by telephone at 504-736-2519 or 1-800-200-GULF, or on the Internet at http://boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx.

SUMMARY

This Supplemental Environmental Impact Statement (EIS) addresses three proposed Federal actions that offer for lease an area on the Gulf of Mexico Outer Continental Shelf (OCS) that may contain economically recoverable oil and gas resources. Under the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program*: *2012-2017* (Five-Year Program) (USDOI, BOEM, 2012a), five proposed lease sales are scheduled for the Central Planning Area (CPA). The remaining three proposed lease sales within the CPA are proposed CPA Lease Sales 235, 241, and 247, which are tentatively scheduled to be held in March 2015, 2016, and 2017, respectively. 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 for the proposed CPA lease sale area, a single EIS is being prepared for the three remaining proposed CPA lease sales. At the completion of this EIS process, a decision will be made on whether or how to proceed with proposed CPA Lease Sale 235. A separate National Environmental Policy Act (NEPA) review, in a form to be determined by the Bureau of Ocean Energy Management (BOEM), will be conducted prior to BOEM's decision on whether or how to proceed with proposed CPA Lease Sales 241 and 247.

This Supplemental EIS updates the baseline conditions and potential environmental effects of oil and natural gas leasing, exploration, development, and production in the CPA since publication of *Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247, Final Environmental Impact Statement* (2012-2017 WPA/CPA Multisale EIS) (USDOI, BOEM, 2012b) and *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement* (WPA 233/CPA 231 Supplemental EIS) (USDOI, BOEM, 2013a).

This Supplemental EIS analyzes the potential impacts of a CPA proposed action on sensitive coastal environments, offshore marine resources, and socioeconomic resources both onshore and offshore. It is important to note that this Supplemental EIS was prepared using the best information that was publicly available at the time the document was prepared. Where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives and if so, it was either acquired or in the event it was impossible or exorbitant to acquire the information, accepted scientific methodologies were applied in its place.

This summary section provides only a brief overview of the proposed CPA lease sales, alternatives, significant issues, potential environmental and socioeconomic effects, and proposed mitigating measures contained in this Supplemental EIS. To obtain the full perspective and context of the potential environmental and socioeconomic impacts discussed, it is necessary to read the entire Supplemental EIS. Relevant discussions of specific topics can be found in the chapters and appendices of this Supplemental EIS as described below.

- **Chapter 1**, The Proposed Actions, describes the purpose of and need for the proposed lease sales, the prelease process, postlease activities, and other OCS-related activities.
- **Chapter 2**, Alternatives Including the Proposed Actions, describes the environmental and socioeconomic effects of a proposed CPA lease sale and alternatives. Also discussed are potential mitigating measures to avoid or minimize impacts.
- **Chapter 3**, Impact-Producing Factors and Scenario, describes activities associated with a proposed lease sale and the OCS Program, and other foreseeable activities that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico.

  Chapter 3.1, Impact-Producing Factors and Scenario—Routine Operations, describes offshore infrastructure and activities (impact-producing factors) associated with a proposed lease sale that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico.

Chapter 3.2, 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 activities associated with a proposed lease sale.

Chapter 3.3, Cumulative Activities Scenario, describes past, present, and reasonably foreseeable future human activities, including non-OCS activities, as well as all OCS activities, that may affect the biological, physical, and socioeconomic resources of the Gulf of Mexico.

- **Chapter 4**, Description of the Environment and Impact Analysis, describes the affected environment and provides analysis of the routine, accidental, and cumulative impacts of a CPA proposed action and the alternatives on environmental and socioeconomic resources of the Gulf of Mexico.

  Chapter 4.1, Proposed Central Planning Area Lease Sales 235, 241, and 247, describes the routine, accidental, and cumulative impacts of a CPA proposed action and two alternatives to a CPA proposed action on the biological, physical, and socioeconomic resources of the Gulf of Mexico.

  Chapter 4 also includes **Chapter 4.2**, Unavoidable Adverse Impacts of the Proposed Actions; **Chapter 4.3**, Irreversible and Irretrievable Commitment of Resources; and **Chapter 4.4**, 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 Supplemental EIS.
- **Chapter 6**, References Cited, is a list of literature cited throughout this Supplemental EIS.
- **Chapter 7**, Preparers, is a list of names of persons who were primarily responsible for preparing and reviewing this Supplemental EIS.
- **Chapter 8**, Glossary, is a list of definitions of selected terms used in this Supplemental EIS.
- **Appendix A**, Air Quality Offshore Modeling Analysis, presents a detailed analysis of the Offshore Coastal Dispersion Model for air quality purposes.
- **Appendix B,** Catastrophic Spill Event Analysis, is a technical analysis of a potential catastrophic event to assist BOEM in meeting the Council on Environmental Quality's (CEQ) requirements for evaluating low-probability catastrophic events under NEPA. The CEQ regulations address impacts with catastrophic consequences in the context of evaluating reasonably foreseeable significant adverse effects in an EIS when they address the issue of incomplete or unavailable information (40 CFR § 1502.22). For NEPA purposes, "'[r]easonably foreseeable' impacts include impacts that have catastrophic consequences even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason" (40 CFR § 1502.22(b)(4)). Therefore, this analysis, which is based on credible scientific evidence, identifies the most likely and most significant impacts from a high-volume blowout and oil spill that continues for an extended period of time. The scenario and impacts discussed in this analysis should not be confused with the scenario and impacts anticipated to result from routine activities or more reasonably foreseeable accidental events of a CPA proposed action.

- **Appendix C**, BOEM-OSRA Catastrophic Run, is a detailed explanation of BOEM's Oil-Spill Risk Analysis (OSRA) and the computer model runs accomplished for this Supplemental EIS.
- **Appendix D**, Recent Publications of the Environmental Studies Program, Gulf of Mexico OCS Region, 2006-Present, contains a listing of publications that originated in BOEM's (and the Agency's predecessors, the Bureau of Ocean Energy Management, Regulation and Enforcement and the Minerals Management Service) Environmental Studies Program of the Gulf of Mexico OCS Region, with a particular focus on the most recent studies.

Proposed Action and Alternatives

The following alternatives were included for analysis in this Supplemental EIS.

Alternatives for Proposed Central Planning Area Lease Sales 235, 241, and 247

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

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006; and

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

The U.S. Department of the Interior (DOI) is conservative throughout the NEPA process and includes the total area within the CPA for environmental review even though the leasing portions of the CPA (subareas or blocks) can be deferred during a Five-Year Program.

The proposed CPA lease sale area encompasses about 63 million acres (ac) of the CPA's 66.45 million ac. As of February 2014, approximately 43.5 million ac of the proposed CPA lease sale area are currently unleased. The estimated amount of natural resources projected to be developed as a result of a proposed CPA lease sale is 0.460-0.894 billion barrels of oil (BBO) and 1.939-3.903 trillion cubic feet (Tcf) of gas (**Table 3-1**).

Alternative B—The Proposed Action Excluding the Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks within the proposed CPA lease sale area, as described for the proposed action (Alternative A), but it would exclude from leasing any unleased blocks subject to the Topographic Features Stipulation. The estimated amount of resources projected to be developed is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas (refer to **Chapter 2.3.2** for further details).

Alternative C—No Action: This alternative is the cancellation of a proposed CPA lease sale. If this alternative is chosen, the opportunity for development of the estimated 0.460-0.894 BBO and 1.939-3.903 Tcf of gas that could have resulted from a proposed CPA lease sale would be precluded during the current 2012-2017 Five-Year Program, but it could again be contemplated as part of a future Five-Year Program. Any potential environmental impacts arising out of a proposed CPA lease sale would not occur, but activities associated with existing leases in the CPA would continue. This alternative is also analyzed in the *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017, Final Environmental Impact Statement* (Five-Year Program EIS) (USDOI, BOEM, 2012c) on a nationwide programmatic level.

Mitigating Measures

Proposed lease stipulations and other mitigating measures designed to reduce or eliminate environmental risks and/or potential multiple-use conflicts between OCS operations and U.S. Department of Defense activities may be applied to the chosen alternative. Ten lease stipulations are proposed for a CPA proposed lease sale—the Topographic Features Stipulation; the Live Bottom (Pinnacle Trend) Stipulation; the Military Areas Stipulation; the Evacuation Stipulation; the Coordination Stipulation; the

Blocks South of Baldwin County, Alabama, Stipulation; the Protected Species Stipulation; the Law of the Sea Convention Royalty Payment Stipulation; the Below Seabed Operations Stipulation; and the Transboundary Stipulation. The Law of the Sea Convention Royalty Payment Stipulation is applicable to proposed CPA lease sales even though it is not an environmental or military stipulation.

Application of lease stipulations will be considered by the Assistant Secretary of the Interior for Land and Minerals (ASLM). The inclusion of the stipulations as part of the analysis of a CPA proposed action does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from a 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 warrant. Any lease stipulations or mitigating measures to be included in a lease sale will be described in the Final Notice of Sale. Mitigating 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 a CPA proposed action (**Chapter 3.1**) and for the OCS Program (**Chapter 3.3**). BOEM's Gulf of Mexico OCS Region developed these scenarios to provide a framework for detailed analyses of potential impacts of a proposed CPA lease sale. 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 CPA proposed action. The analyses are based on a traditionally employed range of activities (e.g., 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 4.1.1**) considers environmental and socioeconomic impacts that may result from the incremental impact of a proposed action when added to all past, present, and reasonably foreseeable future 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 (2012-2051). This includes projected activity from lease sales that have been held, 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 Supplemental EIS, the 2012-2017 WPA/CPA Multisale EIS, and the WPA 233/CPA 231 Supplemental EIS are the result of concerns raised during years of scoping for the Gulf of Mexico OCS Program. Issues related to OCS exploration, development, production, and transportation activities include the potential for 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, impacts to tourism, aesthetic interference, cultural impacts, environmental justice, and conflicts with State coastal zone management programs. Environmental resources and activities identified during the scoping process that warrant environmental analyses include air quality, water quality, coastal barrier beaches and associated dunes, wetlands, seagrass communities, live bottoms, topographic features, *Sargassum* communities, deepwater benthic communities, soft bottom benthic communities, marine mammals, sea turtles, diamondback terrapins, beach mice, coastal and marine birds, Gulf sturgeon, fish resources and essential fish habitat, commercial fisheries, recreational fishing, recreational resources, archaeological resources, and socioeconomic conditions.

Other relevant issues include impacts from the *Deepwater Horizon* explosion, oil spill, and response; impacts from past and future hurricanes on environmental and socioeconomic resources; and impacts on coastal and offshore infrastructure. During the past few years, both the Gulf Coast States and Gulf of Mexico oil and gas activities have been impacted by major hurricanes. The description of the affected environment (**Chapter 4.1.1**) includes impacts from these storms on the physical environment, biological environment, and socioeconomic activities and on OCS-related infrastructure. This Supplemental EIS also considers baseline data in the assessment of impacts from a CPA proposed action on the resources and the environment (**Chapter 4.1.1**).

Impact Conclusions

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action and a proposed action's incremental contribution to the cumulative impacts are described in **Chapter 4.1.1**. A summary of the potential impacts from a CPA proposed action on each environmental and socioeconomic resource and the conclusions of the analyses can be found below.

Air Quality: Emissions of pollutants into the atmosphere from the routine activities associated with a CPA 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, and are expected to be well within the National Ambient Air Quality Standards. While regulations are in place to reduce the risk of impacts from hydrogen sulfide (H_2S) and while no H_2S-related deaths have occurred on the OCS, accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. These emissions from routine activities and accidental events associated with a CPA proposed action are not expected to occur at concentrations that would change onshore air quality classifications.

Water Quality (Coastal and Offshore Waters): Impacts from routine activities associated with a CPA proposed action would be minimal if all existing regulatory requirements are met. Coastal water impacts associated with routine activities include increases in turbidity resulting from pipeline installation and navigation canal maintenance, discharges of bilge and ballast water from support vessels, and run-off from shore-based facilities. Offshore water impacts associated with routine activities result from the discharge of drilling muds and cuttings, produced water, residual chemicals used during workovers, structure installation and removal, and pipeline placement. The discharge of drilling muds and cuttings causes temporary increased turbidity and changes in sediment composition. The discharge of produced water results in increased concentrations of some metals, hydrocarbons, and dissolved solids within an area of about 100 meters (m) (328 feet [ft]) adjacent to the point of discharge. Structure installation and removal and pipeline placement disturb the sediments and cause increased turbidity. In addition, offshore water impacts result from supply and service-vessel bilge and ballast water discharges.

Coastal Barrier Beaches and Associated Dunes: Routine activities associated with a CPA proposed action, such as increased vessel traffic, maintenance dredging of navigation canals, and pipeline installation, would cause negligible impacts. Such impacts would be expected to be restricted to temporary and localized disturbances and not deleteriously affect barrier beaches and associated dunes. Indirect impacts from routine activities are negligible and indistinguishable from direct impacts of onshore activities. The potential impacts from accidental events (primarily oil spills) associated with a CPA proposed action are anticipated to be minimal. Should a spill (other than a catastrophic spill) contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant long-term impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a CPA proposed action.

Wetlands: Routine activities associated with a CPA proposed action are expected to be small, localized, and temporary due to the small length of projected onshore pipelines, the minimal contribution to the need for maintenance dredging, the disposal of OCS wastes, and the mitigating measures that would be used to further reduce these impacts. Indirect impacts from wake erosion and saltwater intrusion are expected to result in low impacts that are indistinguishable from direct impacts from inshore activities. The potential impacts from accidental events (primarily oil spills) are anticipated to be minimal. Overall, impacts to wetland habitats from an oil spill associated with activities related to a CPA proposed action would be expected to be small and temporary because of the nature of the system, regulations, and specific cleanup techniques.

Seagrass Communities: Turbidity impacts from pipeline installation and maintenance dredging associated with a CPA proposed action would be temporary and localized. The increment of impacts from service-vessel transit associated with a CPA proposed action would be minimal. Should an oil spill occur near a seagrass community, impacts from the spill and cleanup would be considered short term in duration and minor in scope. Close monitoring and restrictions on the use of bottom-disturbing equipment to clean up the spill would be needed to avoid or minimize those impacts.

Live Bottoms (Pinnacle Trend and Low Relief): The combination of its depth (200-400 ft; 60-120 m), separation from sources of impacts as mandated by the Live Bottom (Pinnacle Trend) Stipulation and through site-specific seafloor reviews of proposed activity, and a community adapted to sedimentation makes damage to the ecosystem unlikely from routine activities associated with a CPA proposed action. In the unlikely event that oil from a subsurface spill would reach the biota of these communities, the effects would be primarily sublethal for adult sessile biota, and there would be limited incidences of mortality.

Topographic Features: The routine activities associated with a CPA proposed action that would impact topographic feature communities include anchoring, infrastructure and pipeline emplacement, infrastructure removal, drilling discharges, and produced-water discharges. However, adherence to the proposed Topographic Features Stipulation would make damage to the ecosystem unlikely. Contact with accidentally spilled oil would cause lethal and sublethal effects in benthic organisms, but the oiling of benthic organisms is not likely because of the small area of the banks, the scattered occurrence of spills, the depth of the features, and because the proposed Topographic Features Stipulation, if applied, would keep subsurface sources of spills away from the immediate vicinity of topographic features.

Sargassum Communities: The impacts that are associated with a CPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community as a whole. Limited portions of the *Sargassum* community could suffer mortality if it contacts spilled oil or cleanup activities. The *Sargassum* community lives in pelagic waters with generally high water quality and would be resilient to the minor effects predicted. It has a yearly cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community from a CPA proposed action.

Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities: Chemosynthetic and nonchemosynthetic communities are susceptible to physical impacts from structure placement, anchoring, and pipeline installation associated with a CPA proposed action. However, the policy requirements described in Notice to Lessees and Operators (NTL) 2009-G40 greatly reduce the risk of these physical impacts by clarifying the measures that must be taken to ensure avoidance of potential chemosynthetic communities and, by consequence, avoidance of other hard bottom communities. Even in situations where substantial burial of typical benthic infaunal communities occurred, recolonization by populations from widespread, neighboring, soft bottom substrate would be expected over a relatively short period of time for all size ranges of organisms. Potential accidental events associated with a CPA proposed action are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities and the widespread, typical, deep-sea benthic communities.

Soft Bottom Benthic Communities: The routine activities associated with a CPA proposed action that would impact soft bottoms generally occur within a few hundred meters of platforms, and the greatest impacts are seen close to the platform communities. Although localized impacts to comparatively small areas of the soft bottom benthic communities would occur, the impacts would be on a relatively small area of the seafloor compared with the overall area of the seafloor of the CPA (268,922 km^2; 103,831 mi^2). A CPA proposed action is not expected to adversely impact the entire soft bottom environment because the local impacted areas are extremely small compared with the entire seafloor of the Gulf of Mexico and because the soft bottom benthic communities are ubiquitous throughout the Gulf of Mexico.

Marine Mammals: Routine events related to a CPA proposed action are not expected to have adverse effects on the size and productivity of any marine mammal species or population in the northern Gulf of Mexico. Characteristics of impacts from accidental events depend on chronic or acute exposure from accidental events resulting in harassment, harm, or mortality to marine mammals, while exposure to dispersed hydrocarbons is likely to result in sublethal impacts.

Sea Turtles: Routine activities resulting from a CPA proposed action have the potential to harm sea turtles, although this potential is unlikely to rise to a level of significance due to the activity already present in the Gulf of Mexico and due to mitigating measures that are in place. Accidental events associated with a CPA proposed action have the potential to impact small to large numbers of sea turtles. Populations of sea turtles in the northern Gulf of Mexico may be exposed to residuals of oils spilled as a result of a CPA proposed action during their lifetimes. While chronic or acute exposure from accidental events may result in the harassment, harm, or mortality to sea turtles, in the most likely scenarios, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick are expected to most often result in sublethal impacts (e.g., decreased health and/or reproductive fitness and increased vulnerability to disease) to sea turtles. The incremental contribution of a CPA proposed action would not be likely to result in a significant incremental impact on sea turtles within the CPA; in comparison, non-OCS energy-related activities, such as overexploitation, commercial fishing, and pollution, have historically proved to be a greater threat to the sea turtle species.

Diamondback Terrapins: The routine activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of terrapin species or populations in the Gulf of Mexico. Impacts on diamondback terrapins from smaller accidental events are likely to affect individual diamondback terrapins in the spill area, but they are unlikely to rise to the level of population effects (or significance) given the probable size and scope of such spills. Due to the distance of most terrapin habitat from offshore OCS energy-related activities, impacts associated with activities occurring as a result of a CPA proposed action are not expected to impact terrapins or their habitat. The incremental effect of a CPA proposed action on diamondback terrapin populations is not expected to be significant when compared with historic and current non-OCS energy-related activities, such as habitat loss, overharvesting, crabbing, and fishing.

Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice: An impact from the consumption of beach trash and debris associated with a CPA proposed action on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. While potential spills that could result from a CPA proposed action are not expected to contact beach mice or their habitats, large-scale oiling of beach mice could result in extinction, and, if all personnel are not thoroughly trained, oil-spill response and cleanup activities could have a significant impact to the beach mice and their habitat.

Coastal and Marine Birds: The majority of impacts resulting from routine activities associated with a CPA proposed action on threatened and endangered and nonthreatened and nonendangered avian species are expected to be adverse, but not significant. These impacts include behavioral effects, exposure to or intake of OCS-related contaminants and discarded debris, disturbance-related impacts, and displacement of birds from habitats that are destroyed, altered, or fragmented, making these areas otherwise unavailable. Impacts from potential oil spills associated with a CPA proposed action and the effects related to oil-spill cleanup are expected to be adverse, but not significant. Oil spills, irrespective of size, can result in some mortality as well as sublethal, chronic short- and long-term effects, in addition to potential impacts to food resources. The effect of cumulative activities on coastal and marine birds is expected to result in discernible changes to avian species composition, distribution, and abundance. The incremental contribution of a CPA proposed action to cumulative impacts is expected to be adverse, but not significant, because it may seriously alter avian species' composition and abundance due to reductions in the overall carrying capacity of disturbed habitats, and possibly to the availability, abundance, and distribution of preferred food resources.

Gulf Sturgeon: Routine activities associated with a CPA proposed action, such as the installation of pipelines, maintenance dredging, potential vessel strikes, and nonpoint-source runoff from onshore facilities, would cause negligible impacts and would not deleteriously affect Gulf sturgeon. Indirect impacts from routine activities to inshore habitats are negligible and indistinguishable from direct impacts of inshore activities and are further reduced through mitigations and regulations. The potential impacts from accidental events, mainly oil spills associated with a CPA proposed action, are anticipated to be minimal. Because of the floating nature of oil, reduced toxicity through weathering (offshore dispersant treatment) and the small tidal range of the Gulf of Mexico, oil spills alone would typically have very little impact on benthic feeders such as the Gulf sturgeon. The incremental contribution of a CPA proposed action to the cumulative impact is negligible.

Fish Resources and Essential Fish Habitat: Fish resources and essential fish habitat could be impacted by coastal environmental degradation potentially caused by canal dredging, increases in infrastructure, and inshore spills and marine environmental degradation possibly caused by pipeline trenching, offshore discharges, and offshore spills. Impacts of routine dredging and discharges are localized in time and space and are regulated by Federal and State agencies through permitting processes; therefore, there would be minimal impact to fish resources and essential fish habitat from these routine activities associated with a CPA proposed action. Accidental events that could impact fish resources and essential fish habitat include blowouts and oil or chemical spills. If a spill were to occur as a result of a CPA proposed action and if it was proximate to mobile fishes, the impacts of the spill would depend on multiple factors, including the amount spilled, the areal extent of the spill, the distance of the spill from particular essential fish habitats (e.g., nursery habitats), and the type and toxicity of oil spilled. Much of the sensitive essential fish habitat would have decreased effects from oil spills because of the depths many are found and because of the distance that these low-probability spills would occur from many of the essential fish habitats (due to stipulations, NTL's, etc.). If there is an effect of an oil spill on fish resources in the Gulf of Mexico, it is expected to cause a minimal decrease in standing stocks of any population. This is because most spill events would be localized, therefore affecting a small portion of fish populations.

Commercial Fisheries: Routine activities in the CPA, such as seismic surveys and pipeline trenching, would cause negligible impacts and would not deleteriously affect commercial fishing activities. Indirect impacts from routine activities to inshore habitats are negligible and indistinguishable from direct impacts of inshore activities on commercial fisheries. The potential impacts from accidental events, such as a well blowout or an oil spill, associated with a CPA proposed action are anticipated to be minimal. Commercial fishermen are anticipated to avoid the area of a well blowout or an oil spill. Large spills may impact commercial fisheries by area closures. The extent of impact depends on the areal extent and length of the closure. The impact of spills on catch or value of catch would depend on the volume and location (i.e., distance from shore) of the spill, as well as the physical properties of the oil spilled.

Recreational Fishing: There could be minor and short-term, space-use conflicts with recreational fishermen during the initial phases of a CPA proposed action. A CPA proposed action could also lead to low-level environmental degradation of fish habitat, which would also negatively impact recreational fishing activity. However, these minor negative effects would be offset by the beneficial role that oil platforms serve as artificial reefs for fish populations. An oil spill would likely lead to recreational fishing closures in the vicinity of the oil spill. Except for a catastrophic spill such as the *Deepwater Horizon* oil spill, oil spills should not affect recreational fishing to a large degree due to the likely availability of substitute fishing sites in neighboring regions.

Recreational Resources: Routine OCS actions can cause minor disturbances to recreational resources, particularly beaches, through increased levels of noise, debris, and rig visibility. The oil spills most likely to result from a CPA proposed action would be small, of short duration, and not likely to impact Gulf Coast recreational resources. Should an oil spill occur and contact a beach area or other recreational resource, it would cause some disruption during the impact and cleanup phases of the spill. However, except for a catastrophic spill such as the *Deepwater Horizon* oil spill, these effects are likely to be small in scale and of short duration.

Archaeological Resources (Historic and Prehistoric): The greatest potential impact to an archaeological resource as a result of routine activities associated with a CPA proposed action would result from direct contact between an offshore activity (e.g., platform installation, drilling rig emplacement, structure removal or site clearance operation, and dredging or pipeline project) and a historic or prehistoric site. The archaeological survey and archaeological clearance of sites, where required prior to an operator beginning oil and gas activities on a lease, are expected to be highly effective at identifying possible offshore archaeological sites; however, should such contact occur, there would be localized damage to or loss of significant and/or unique archaeological information. It is expected that coastal archaeological resources would be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

It is not very likely that a large oil spill would occur and contact coastal prehistoric or historic archaeological sites from accidental events associated with a CPA proposed action. Should a spill contact a prehistoric archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting resulting in the irreversible loss of unique or significant archaeological information. The major effect from an oil-spill impact on coastal historic archaeological sites would be visual contamination, which, while reversible, could result in additional impacts to fragile cultural materials from the cleaning process.

Land Use and Coastal Infrastructure: A CPA proposed action would not require additional coastal infrastructure, with the exception of possibly one new gas processing facility and one new pipeline landfall, and it would not alter the current land use of the analysis area. The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a CPA proposed action. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle such development. There is also sufficient land to construct a new gas processing plant in the analysis area, should it be needed. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills, as well as vessel collisions, could have short-term adverse effects on coastal infrastructure, requiring cleanup of any oil or chemicals spilled.

Demographics: A CPA proposed action is projected to minimally affect the demography of the analysis area. Population impacts from a CPA proposed action are projected to be minimal (<1% of total population) for any economic impact area in the Gulf of Mexico region. The baseline population patterns and distributions, as projected and described in **Chapter 4.1.1.23**, are expected to remain unchanged as a result of a CPA proposed action. 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 (from elsewhere within or outside the U.S.), which is projected to move into focal areas such as Port Fourchon. Accidental events associated with a CPA proposed action, such as oil or chemical spills, blowouts, and vessel collisions, would likely have no effects on the demographic characteristics of the Gulf coastal communities.

Economic Factors: A CPA proposed action is expected to generate a <1 percent increase in employment in any of the coastal subareas, even when the net employment impacts from accidental events are included. Most of the employment related to a CPA proposed action is expected to occur in Louisiana and Texas. The demand would be met primarily with the existing population and labor force.

Environmental Justice: Environmental justice implications arise indirectly from onshore activities conducted in support of OCS exploration, development, and production. Because the onshore infrastructure support system for OCS-related industry (and its associated labor force) is highly developed, widespread, and has operated for decades within a heterogeneous Gulf of Mexico population, a CPA proposed action is not expected to have disproportionately high or adverse environmental or health effects on minority or low-income people. A CPA proposed action would help to maintain ongoing levels of activity**,** which may or may not result in the expansion of existing infrastructure. For a detailed discussion of scenario projections and the potential for expansion at existing facilities and/or construction of new facilities, refer to **Chapter 3.1.2**.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

°C	degree Celsius
°F	degree Fahrenheit
2012-2017 WPA/CPA Multisale EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247; Final Environmental Impact Statement; Volumes I-III*
ac	acre
AEDP	area evaluation and decision process
Agreement	Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico
AL	Alabama
API	American Petroleum Institute
ASLM	Assistant Secretary of the Interior for Land and Minerals
BAST	best available and safest technology
bbl	barrel
BBO	billion barrels of oil
BCR	Bird Conservation Region
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
BP	British Petroleum
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act of 1970
CAAA	Clean Air Act Amendments of 1990
CAMx	Comprehensive Air Quality Model with extensions
CD	Consistency Determination
CEQ	Council on Environmental Quality
CEVI	Coastal Economic Vulnerability Index
CEWAF	water-accommodated fractions plus COREXIT 9500
CFR	Code of Federal Regulations
CG	Coast Guard (also: USCG)
CH_4	methane
CIAP	Coastal Impact Assistance Program
CMP	Coastal Management Plans
CO	carbon monoxide
CO_2	carbon dioxide
COE	Corps of Engineers (U.S. Army)
CPA	Central Planning Area
CSA	Continental Shelf Associates
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DDE	dichloro-diphenyldichloro-ethylene
DOCD	development operations coordination document
DOD	Department of Defense (U.S.) (also: USDOD)
DOI	Department of the Interior (U.S.) (also: USDOI)
DPP	development and production plan
EA	environmental assessment
EFH	essential fish habitat
e.g.	for example
EIA	Economic Impact Area
EIS	environmental impact statement

EP	exploration plan
EPA	Eastern Planning Area
EPA 225/226 EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2014 and 2016; Eastern Planning Area Lease Sales 225 and 226; Final Environmental Impact Statement*
EPS	exopolysaccharides
ERMA	Environmental Response Management Application
ESA	Endangered Species Act of 1973
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
et al.	and others
et seq.	and the following
Five-Year Program	*Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017*
Five-Year Program EIS	*Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017, Final Environmental Impact Statement*
FL	Florida
FPSO	floating production, storage, and offloading system
FR	*Federal Register*
ft	feet
FWS	Fish and Wildlife Service
G&G	geological and geophysical
g	gram
gal	gallon
GC-HARMS	*Gulf Coast Health Alliance: Health Risks Related to the Macondo Spill*
GIWW	Gulf Intracoastal Waterway
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
GS	Geological Survey (also: USGS)
GuLF STUDY	Gulf Long-Term Follow-Up Study
GWEI	Gulfwide Emissions Inventory
H_2S	hydrogen sulfide
ha	hectare
i.e.	specifically
in	inch
IPCC	Intergovernmental Panel on Climate Change
JITF	Joint Industry Task Force
kg	kilogram
kg/d	kilogram/day
km	kilometer
L	liter
LA	Louisiana
LA Hwy 1	Louisiana Highway 1
LC_{50}	lethal concentration to 50 percent
LCA	Louisiana Coastal Area
LNG	liquefied natural gas
m	meter
MARPOL	International Convention for the Prevention of Pollution from Ships
MCVAFF	Mississippi Coalition for Vietnamese-American Fisher Folks and Families
mi	mile
mm	millimeter
MMbbl	million barrels
MMcf	million cubic feet
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MOA	Memorandum of Agreement

MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MS	Mississippi
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
nmi	nautical-mile
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Prepare an EIS
NOS	National Ocean Service
NPDES	National Pollutant and Discharge Elimination System
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NTL	Notice to Lessees and Operators
O_3	ozone
OCD	Offshore Coastal Dispersion
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OSAT	Operational Science Advisory Team
OSHA	Occupational Safety and Health Administration
OSRA	Oil Spill Risk Analysis
P.L.	Public Law
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
$PM_{2.5}$	particulate matter less than or equal to 2.5 μm
PM_{10}	particulate matter less than or equal to 10 μm
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
ROD	Record of Decision
ROTAC	Regional Operations Technology Assessment Committee
ROV	remotely operated vehicle
RP	Recommended Practice
RTR	Rigs-to-Reefs
SAV	submerged aquatic vegetation
SCAT	Shoreline Cleanup and Assessment Team
Secretary	Secretary of the Interior
SO_x	sulphur oxides
Stat.	Statute
STOF-THPO	Seminole Tribe of Florida-Tribal Historic Preservation Officer
sVGP	Small Vessel General Permit
TA&R	Technology Assessment and Research Program
Tcf	trillion cubic feet
Trustee Council	Natural Resource Damage Assessment Trustee Council
TX	Texas
U.S.	United States
U.S.C.	United States Code
UME	unusual mortality event
USCG	U.S. Coast Guard (also: CG)
USDHS	U.S. Department of Homeland Security

USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense (also: DOD)
USDOE	U.S. Department of the Energy
USDOI	U.S. Department of the Interior (also: DOI)
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey (also: GS)
VGP	Vessel General Permit
VOC	volatile organic compound
VSP	vertical seismic profiling
W.	west
WAF	water-accommodated fractions
WPA	Western Planning Area
WPA 233/CPA 231 Supplemental EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement*
WPA 238/246/248 Supplemental EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2014-2016; Western Planning Area Lease Sales 238, 246, and 248; Final Environmental Impact Statement*
yr	year

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 pounds
1 nautical mile (nmi) = 6,076 ft (1,852 m) or 1.15 mi (1.85 km)

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 Supplemental Environmental Impact Statement (EIS) are to offer for lease certain Outer Continental Shelf (OCS) blocks located in the Central Planning Area (CPA) of the Gulf of Mexico (GOM) (**Figure 1-1**). Under the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017* (Five-Year Program) (USDOI, BOEM, 2012a), proposed CPA Lease Sales 235, 241, and 247 are tentatively scheduled to be held in March 2015, 2016, and 2017, respectively. The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources in accordance with the Outer Continental Shelf Lands Act (OCSLA) of 1953 (67 Stat. 462), as amended (43 U.S.C. §§ 1331 *et seq.*). The proposed CPA lease sales will provide qualified bidders the opportunity to bid upon and lease acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas. Under the OCSLA, for each potential lease sale in the Five-Year Program, the Bureau of Ocean Energy Management (BOEM) makes individual decisions on whether and how to proceed with a proposed lease sale. Although the analyses cover more than one proposed lease sale, this Supplemental EIS will be used by BOEM to support a decision on proposed CPA Lease Sale 235. Additional National Environmental Policy Act (NEPA) reviews, as appropriate, will be prepared prior to individual lease sale decisions on proposed CPA Lease Sales 241 and 247 to address any newly available significant information relevant to those proposed actions (refer to **Chapter 2.1**). Those NEPA reviews will tier from and incorporate by reference the analyses from previous lease sale EIS's.

The need for the proposed actions is to further the orderly development of OCS resources. The Gulf of Mexico 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 serves as the feedstock for liquid hydrocarbon products, including gasoline, aviation and diesel fuel, and various petrochemicals. Oil from the CPA would help reduce the Nation's need for oil imports and lessen the dependence on foreign oil. The U.S. consumed 18.6 million barrels (MMbbl) of oil per day in 2012 (USDOE, Energy Information Administration, 2013a). The Energy Information Administration projects the total U.S. consumption of liquid fuels, including fossil fuels and biofuels, to remain at about 19.1 MMbbl of oil per day from 2013 to 2040 (USDOE, Energy Information Administration, 2013b). Altogether, net imports of crude oil and petroleum products (imports minus exports) accounted for 45 percent of our total petroleum consumption in 2011. The U.S. crude oil imports stood at 8.4 MMbbl of oil per day in 2011. Petroleum product imports were 2.4 MMbbl of oil per day in 2011. Exports totaled 2.9 MMbbl of oil per day in 2011, mainly in the form of distillate fuel oil, petroleum coke, and residual fuel oil. In 2011, the Nation's biggest supplier of crude oil and petroleum-product imports was Canada (29%), with countries in the Persian Gulf being the second largest source (22%) (USDOE, Energy Information Administration, 2012). Oil produced from the CPA would also reduce the environmental risks associated with transoceanic oil tankering from sources overseas. Natural gas is not easily transported, making domestic production especially desirable. The need for domestic natural gas reserves is also based upon its use as an environmentally preferable alternative to oil for generating electricity.

This Supplemental EIS tiers from and incorporates by reference all of the relevant analyses from *Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247, Final Environmental Impact Statement* (2012-2017 WPA/CPA Multisale EIS) (USDOI, BOEM, 2012b); and *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement* (WPA 233/CPA 231 Supplemental EIS) (USDOI, BOEM, 2013a). The 2012-2017 WPA/CPA Multisale EIS notes that two sales may be held each year during the Five-Year Program—one in the WPA and one in the CPA.

This Supplemental EIS focuses on updating the baseline conditions and potential environmental effects of oil and natural gas leasing, exploration, development, and production in the CPA since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. This Supplemental EIS analyzes the potential impacts of a CPA proposed action on the marine, coastal, and human environments. This Supplemental EIS will also assist decisionmakers in making informed, future decisions regarding the approval of operations, as well as leasing. At the completion of the NEPA process, a decision will be made only for proposed CPA Lease Sale 235. A separate NEPA review, in a form to be determined by BOEM, will be conducted prior to BOEM's decision on whether or how to proceed with proposed CPA Lease Sales 241 and 247. The analysis in this Supplemental EIS also focuses on the potential environmental effects of oil and natural gas leasing, exploration, development, and production in the areas identified through the Area Identification (Area ID) procedure as the proposed lease sale area. In addition to the No Action alternative (i.e., cancel a proposed lease sale), other alternatives are considered for a proposed CPA lease sale, such as deferring certain areas from a proposed lease sale.

The Secretary of the Interior (Secretary) has designated BOEM as the administrative agency responsible for the mineral leasing of submerged OCS lands and for the supervision of most offshore operations after lease issuance. BOEM is responsible for managing development of the Nation's offshore resources in an environmentally and economically responsible way. The functions of BOEM include leasing, exploration and development, plan administration, environmental studies, NEPA analysis, resource evaluation, economic analysis, and the renewable energy program. The Bureau of Safety and Environmental Enforcement (BSEE) is responsible for enforcing safety and environmental regulations. The functions of BSEE include all field operations, including permitting and research, inspections, offshore regulatory programs, oil-spill response, and training and environmental compliance functions.

1.2. Description of the Proposed Actions

The proposed actions are the next three oil and gas lease sales in the CPA as scheduled in the Five-Year Program. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR § 1502.4). Since the proposed CPA lease sales are in the same area and their projected activities are very similar, BOEM has decided to prepare a single Supplemental EIS for proposed CPA Lease Sales 235, 241, and 247. The analyses contained within this Supplemental EIS examine impacts from a single, typical CPA lease sale. The findings of these analyses can be applied individually to each of the proposed lease sales, i.e., proposed WPA Lease Sales 235, 241, and 247. While the impact analyses can be applied to each proposed lease sale, this Supplemental EIS is a decision document for only proposed CPA Lease Sale 235. Additional NEPA reviews will be conducted prior to individual decisions on proposed CPA Lease Sales 241 and 247 to address any newly available significant information relevant to those proposed actions (refer to **Chapter 2.1**).

Proposed CPA Lease Sales 235, 241, and 247 are tentatively scheduled to be held in March 2015, 2016, and 2017, respectively. The proposed CPA lease sale area encompasses about 63 million acres (ac) of the total CPA area of 66.45 million ac. This area begins 3 nautical miles (nmi) (3.5 miles [mi]; 5.6 kilometers [km]) offshore Louisiana, Mississippi, and Alabama, and extends seaward to the limits of the United States' jurisdiction over the continental shelf (often referred to as the Exclusive Economic Zone) in water depths up to approximately 3,346 meters (m) (10,978 feet [ft]) (**Figure 1-1**). As of February 2014, approximately 43.5 million ac of the proposed CPA lease sale area are unleased.

The estimated amount of resources projected to be developed as a result of a single, typical lease sale (i.e., proposed CPA Lease Sale 235) is 0.460-0.894 billion barrels of oil (BBO) and 1.939-3.903 trillion cubic feet (Tcf) of gas. A proposed CPA lease sale includes proposed lease stipulations designed to reduce environmental risks; these stipulations are discussed in **Chapter 2.3.1.3** of this Supplemental EIS and in Chapter 2.4.1.3 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

1.3. Regulatory Framework

Federal laws mandate the OCS leasing program (e.g., OCSLA) and the environmental review process (e.g., NEPA). Several Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies (e.g., Coastal Zone Management Act, Endangered Species Act, the Magnuson-Stevens 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 applicable Federal, State, and local laws and regulations. A detailed list of the major, applicable Federal laws, regulations, and Executive Orders are listed below.

Regulation, Law, and Executive Order	Citation
Outer Continental Shelf Lands Act	43 U.S.C. §§ 1331 *et seq.*
National Environmental Policy Act of 1969	42 U.S.C. §§ 4321-4347 40 CFR parts 1500-1508
Coastal Zone Management Act of 1972	16 U.S.C. §§ 1451 *et seq.* 15 CFR part 930
Endangered Species Act of 1973	16 U.S.C. §§ 1631 *et seq.*
Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. §§ 1251 *et seq.*
Essential Fish Habitat Consultation (in 1996 reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act)	P.L. 94-265 16 U.S.C. §§ 1801-1891 50 CFR part 600 subpart K
Marine Mammal Protection Act	16 U.S.C. §§ 1361 *et seq.*
Clean Air Act	42 U.S.C. §§ 7401 *et seq.* 40 CFR part 55
Clean Water Act	33 U.S.C. §§ 1251 *et seq.*
Harmful Algal Bloom and Hypoxia Research and Control Act	P.L. 105-383
Oil Pollution Act of 1990	33 U.S.C. §§ 2701 *et seq.* Executive Order 12777
Comprehensive Environmental Response, Compensation, and Liability Act of 1980	42 U.S.C. §§ 9601 *et seq.*
Resource Conservation and Recovery Act	42 U.S.C. §§ 6901 *et seq.*
Marine Plastic Pollution Research and Control Act	33 U.S.C. §§ 1901 *et seq.*
National Fishing Enhancement Act of 1984	33 U.S.C. §§ 2601 *et seq.*
Fishermen's Contingency Fund	43 U.S.C. §§ 1841-1846
Ports and Waterways Safety Act of 1972	33 U.S.C. §§ 1223 *et seq.*
Marine and Estuarine Protection Acts	33 U.S.C. §§ 1401 *et seq.*
Marine Protection, Research, and Sanctuaries Act of 1972	P.L. 92-532
National Estuarine Research Reserves	16 U.S.C. § 1461, Section 315
National Estuary Program	P.L. 100-4
Coastal Barrier Resources Act	16 U.S.C. §§ 3501 *et seq.*
National Historic Preservation Act	16 U.S.C. §§ 470 *et seq.*
Rivers and Harbors Act of 1899	33 U.S.C. §§ 401 *et seq.*
Occupational Safety and Health Act of 1970	29 U.S.C. §§ 651 *et seq.*
Energy Policy Act of 2005	P.L. 109-58
Gulf of Mexico Energy Security Act of 2006	P.L. 109-432
Marine Debris Research, Prevention, and Reduction Act	P.L. 109-449
American Indian Religious Freedom Act of 1978	P.L. 95-341 42 U.S.C. §§ 1996 and 1996a
Migratory Bird Treaty Act of 1918	16 U.S.C. §§ 703 *et seq.*
Submerged Lands Act of 1953	43 U.S.C. §§ 1301 *et seq.*
49 U.S.C. § 44718: Structures Interfering with Air Commerce	49 U.S.C. § 44718
Marking of Obstructions	14 U.S.C. § 86
Wilderness Act of 1964	P.L. 88-577 16 U.S.C. §§ 1131-1136 78 Stat. 890

Toxic Substances Control Act	P.L. 94-469 15 U.S.C. §§ 2601-2697 Stat. 2003
Bald Eagle Protection Act of 1940	P.L. 86-70 16 U.S.C. §§ 668-668d
Executive Order 11988: Floodplain Management	42 FR 26951 (1977); amended by Executive Order 12148 (7/20/79)
Executive Order 11990: Protection of Wetlands	42 FR 26961 (1977); amended by Executive Order 12608 (9/9/87)
Executive Order 12114: Environmental Effects Abroad	44 FR 1957 (1979)
Executive Order 12898: Environmental Justice	59 FR 5517 (1994)
Executive Order 13007: Indian Sacred Sites	61 FR 26771-26772 (1996)
Executive Order 13089: Coral Reef Protection	63 FR 32701-32703 (1998)
Executive Order 13175: Consultation and Coordination with Indian Tribal Governments	65 FR 67249-67252 (2000)
Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds	66 FR 3853 (2001)

1.3.1. Recent BOEM/BSEE Rule Changes

In light of the *Deepwater Horizon* explosion, oil spill, and response, the Federal Government, along with industry, increased their rules and safety measures related to oil-spill prevention, containment, and response. Additionally, the Federal Government and industry have increased their research and reform in response to the *Deepwater Horizon* explosion, oil spill, and response through government-funded research, industry-funded research, and joint partnerships. These joint partnerships are often between government agencies, industry, and nongovernment organizations. For more information about the recent BOEM/BSEE rule changes, refer to Chapters 1.3 and 1.5 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

1.3.1.1. Recent and Ongoing Regulatory Reform and Government-Sponsored Research

BOEM and BSEE have instituted regulatory reforms responsive to many of the recommendations expressed in the various reports prepared following the *Deepwater Horizon* explosion, oil spill, and response. To date, regulatory reform has occurred through both prescriptive and performance-based regulation and guidance, as well as OCS safety and environmental protection requirements, as described in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The reforms strengthen the requirements for all aspects of OCS operations. Ongoing reform and research endeavors to improve workplace safety and to strengthen oil-spill prevention planning, containment, and response are described in detail in Chapter 1.3.1.2 of the 2012-2017 WPA/CPA Multisale EIS.

The "Oil and Gas and Sulphur Operations in the Outer Continental Shelf—Revisions to Safety and Environmental Management Systems" (SEMS II) Final Rule was completed in June 2013 (*Federal Register*, 2013a). This final rule, also known as the Workplace Safety Rule, includes refinements to the existing SEMS program. The SEMS II Rule amends the existing regulations to require operators to develop and implement additional provisions involving stop work authority and ultimate work authority, establishes requirements for reporting unsafe working conditions, and requires employee participation in the development and implementation of their SEMS programs. In addition, the final rule requires the use of independent third parties to perform the audits of the operators' programs.

The SEMS II Rule provides greater protection by supplementing operators' SEMS programs with employee training, empowering field level personnel with safety management decisions, and strengthening auditing procedures by requiring them to be environmental management systems. The SEMS is a nontraditional, performance-focused tool for integrating and managing offshore operations. The purpose of SEMS is to enhance the safety of operations by reducing the frequency and severity of accidents. There are four principal SEMS objectives:

(1) focus attention on the influences that human error and poor organization have on accidents;

(2) continuous improvement in the offshore industry's safety and environmental records;

(3) encourage the use of performance-based operating practices; and

(4) collaborate with industry in efforts that promote the public interests of offshore worker safety and environmental protection (*Federal Register*, 2013a).

In addition, on April 30, 2013, BSEE and the U.S. Coast Guard (USCG) entered into a Memorandum of Agreement (MOA) entitled "Safety and Environmental Management Systems (SEMS) and Safety Management Systems (SMS)." The purpose of this MOA is to

- establish a process to determine areas relevant to safety and environmental management within the jurisdiction of both the USCG and BSEE where joint policy or guidance is needed;
- ensure that any future OCS safety and environmental management regulations do not place inconsistent requirements on industry; and
- establish a process to develop joint policy or guidance on safety and environmental management systems (*Federal Register*, 2013a).

1.3.1.2. Recent and Ongoing Industry Reform and Research

Shortly after the *Deepwater Horizon* explosion, oil spill, and response, various industry trade associations formed four Joint Industry Task Forces (JITF's) to learn from the *Deepwater Horizon* explosion, oil spill, and response and to advance industry practices. The JITF's are comprised of member companies and affiliates of the American Petroleum Institute (API), the International Association of Drilling Contractors, Independent Petroleum Association of America, National Ocean Industries Association, and U.S. Oil and Gas Association. The ultimate objectives of the JITF's are to reduce risk and to improve the industry's capabilities in safety, environmental performance, and spill prevention and response. Chapter 1.3.1.3 of the 2012-2017 WPA/CPA Multisale EIS describes in detail the recommendations from the JITF's that have led to the reform of industry standards, recommended practices, and guidelines.

In March 2013, the API completed Recommended Practice (RP) 96: "Deepwater Well Design and Construction" (API, 2013a). This standard provides well design and operational considerations for the safe construction of a deepwater well, including the drilling and completion activity performed with a subsea blowout preventer (BOP), a marine drilling riser, and a subsea wellhead.

The API also completed Balloted Bulletin 97: "Well Construction Interface Document Guidelines" in May 2013 (API, 2013b). These guidelines aim to meet DOI's objective by being a bridging document between the drilling contractor's Health, Safety, and Environmental safety case and the operator's SEMS, and they will address safety and risk management considerations on a well-by-well basis.

1.4. PRELEASE PROCESS

Scoping for this Supplemental EIS was conducted in accordance with the Council on Environmental Quality's (CEQ) guidelines on 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 BOEM an opportunity to update the Gulf of Mexico OCS Region's environmental and socioeconomic information base. BOEM conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for proposed CPA Lease Sales 235, 241, and 247 and for this Supplemental EIS. While scoping is an ongoing process, it officially commenced on August 23, 2013, with the publication of the Notice of Intent to Prepare an EIS (NOI) in the *Federal Register* (2013b). Additional public notices were distributed via local newspapers, the U.S. Postal Service, and the Internet. A 30-day comment period was provided; it closed on September 23, 2013. Federal, State, and local governments, along with other interested parties, were invited to send written comments to the Gulf of Mexico OCS Region on the scope of this Supplemental EIS. Comments were received in response to the NOI from Federal, State, and local government agencies; interest groups; industry; businesses; and the general public on the scope of this Supplemental EIS, significant issues that should be addressed, alternatives that should be considered, and mitigating measures. All scoping comments received were considered in the preparation of the Draft Supplemental EIS. The comments have been summarized in **Chapter 5.3**, "Development of the Draft Supplemental EIS."

On October 24, 2012, BOEM released its Area ID decision. The Area ID is an administrative prelease step that describes the geographical area of the proposed actions (proposed lease sale area) and identifies the alternatives, mitigating measures, and issues to be analyzed in the appropriate NEPA document. As mandated by NEPA, this Supplemental EIS analyzes the potential impacts of the CPA proposed actions on the marine, coastal, and human environments.

BOEM will mail copies of the Draft Supplemental EIS for review and comment to Federal, State, and local government agencies; interest groups; industry; the general public; and local libraries. To initiate the public review and comment period on the Draft Supplemental EIS, BOEM will publish a Notice of Availability (NOA) in the *Federal Register*. In addition, public notices will be mailed with the Draft Supplemental EIS and will be placed on BOEM's Internet website (http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx).

A consistency review will be performed in accordance with the Coastal Zone Management Act (CZMA), and a Consistency Determination (CD) will be prepared for each affected State prior to each proposed CPA lease sale. To prepare the CD's, BOEM reviews each State's Coastal Management Program (CMP) and analyzes the potential impacts as outlined in this Supplemental EIS, new information, and applicable studies as they pertain to the enforceable policies of each CMP. Based on the analyses, BOEM's Director makes an assessment of consistency, which is then sent to each State with the Proposed Notice of Sale (NOS). If a State disagrees with the Bureau of Ocean Energy Management's CD, the State is required to do the following under the CZMA: (1) indicate how BOEM's presale proposal is inconsistent with its CMP; (2) suggest alternative measures to bring BOEM's proposal into consistency with their CMP; 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. In the event of a disagreement between a Federal agency and the State's CMP regarding consistency of the proposed lease sales, either BOEM or the State may request mediation. The regulations provide for an opportunity to resolve any differences with the State, but the CZMA allows BOEM to proceed with a proposed lease sale despite any unresolved disagreements if the Federal agency clearly describes to the State's CMP, in writing, how the activity is consistent to the maximum extent practicable with the State's CMP.

Prior to proposed CPA Lease Sale 235, which is tentatively scheduled for March 2015, and the Final Supplemental EIS, BOEM will publish an NOA in the *Federal Register*. BOEM will send copies of the Final Supplemental EIS to Federal, State, and local agencies; interest groups; industry; the general public; and local libraries. In addition, public notices will be mailed with the Final Supplemental EIS and will be placed on BOEM's Internet website (http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx). At the completion of this EIS process, a decision will be made for proposed CPA Lease Sale 235. A separate NEPA review will be conducted prior to proposed CPA Lease Sales 241 and 247.

The Final Supplemental EIS is not a decision document. The Assistant Secretary of the Interior for Land and Minerals Management (ASLM) will make and announce the decision on whether to hold each lease sale (i.e., one each for proposed CPA Lease Sales 235, 241 and 247) and the particulars of the lease sale if it is to be held, such as mitigations that will be imposed as part of the lease sale. A NEPA Record of Decision (ROD) will memorialize the decision and will identify BOEM's preferred alternative for each lease sale, as well as the environmentally preferable alternative, if different. The ROD will summarize the proposed action and the alternatives evaluated in this Supplemental EIS, the information considered in reaching the decision, and the adopted mitigations.

A Proposed NOS will become available to the public 4-5 months prior to each proposed lease sale. A notice announcing the availability of the Proposed NOS 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 NOS, including lease sale configuration and terms and conditions.

If the decision by the ASLM is to hold a proposed lease sale, a Final NOS will be published in its entirety in the *Federal Register* at least 30 days prior to the lease sale date, as required by the OCSLA.

Measures to Enhance Transparency and Effectiveness in the Leasing and Tiering Process

The following discussion is from the Five-Year Program EIS and has been incorporated into this Supplemental EIS for information purposes.

BOEM realizes that each region is different in terms of mineral resources and dependent economies, the relative state of infrastructure and support industries, and the sensitivity of ecosystems, environmental resources, and communities; and that a leasing strategy needs to be sensitive to those differences, but also that it must be consistent with OCSLA principles. BOEM envisions a phased OCSLA process that minimizes multiple-use and environmental conflicts to the extent possible during the Five-Year Program implementation, that makes lease sale decisions in the context of the best available information, and that discloses clear reasons for those decisions, even in the face of uncertainty. This vision is consistent with the National Ocean Policy Implementation Plan and related Marine Planning initiatives, all of which provide a complementary framework for space-use conflict considerations.

BOEM is committing to several process enhancements to ensure transparency during the phased OCSLA and tiered NEPA processes of this Five-Year Program. Although specific approaches to implementation may be tailored to the different needs of the Regions and their stakeholders, BOEM is determined to improve the effectiveness of the tiering process (40 CFR § 1508.28) through the following:

- **Alternative and Mitigation Tracking Table.** BOEM has established an alternative and mitigation tracking table to provide increased visibility into the consideration of recommendations for deferrals, mitigations, and alternatives at different stages of the leasing process. Beginning with the Five-Year Program EIS, the table tracks the lineage and treatment of suggestions for spatial exclusions, temporal deferrals, and/or mitigation from the Five-Year Program, to the lease sale phase, and on to the plan phase. This table allows commenters to see how and at what stage of the process their concerns are being considered. BOEM will maintain a table that will be updated as deferral requests are considered at the lease sale and plan stages and as new requests are made. The alternative and mitigation tracking table has been placed on BOEM's website at http://www.boem.gov/5-year/2012-2017/Tracking-Table/. A link to the table will be provided in the lease sale documents and in the annual report, which is discussed below.

- **Strengthening the Prelease Sale Process.** BOEM is taking a number of steps to enhance opportunities for members of the public to comment and provide new information in the prelease sale planning process. Historically, the Call for Information (Call), which is the first step in the Prelease Sale Process, has generally asked for industry to nominate specific blocks or descriptions of areas within the Five-Year Program area for which they have the most interest. The NOI requests comments from other Federal, State, and local governments, nongovernmental organizations, and the general public on issues that should be addressed and alternatives that should be considered in the NEPA documents that will be prepared for the action.

- **Annual Progress Report.** BOEM will publish an annual progress report on the approved Five-Year Program that includes an opportunity for stakeholders and the public to comment on the Five-Year Program's implementation. Under Section 18(e) of the OCSLA, the Secretary must review annually the approved Five-Year Program. Historically, this has been an internal review process that reported to the Secretary any information or events that might result in a revision to the Five-Year Program. If the revision is considered significant under the OCSLA, the Five-Year Program can only be revised and reapproved by following the same Section 18 steps used to originally develop the Program. However, once the Section 18 process has been initiated for the next Five-Year Program, the annual review is subsumed in that process, as the same substantive and procedural requirements are being addressed.

The findings of this progress report may lead the Secretary to revise the Five-Year Program by reducing the size of, delaying, or canceling scheduled lease sales. If the desired revisions are considered significant, such as including new areas for consideration or more lease sales in areas already included, the entire Section 18 process must be followed, in essence resulting in the preparation of a new Program.

- **Systematic Planning.** BOEM is committed to engaging in systematic planning opportunities that foster improved governmental coordination, communication, and information exchange. As the only agency authorized to grant renewable energy, marine mineral, and oil and gas leases on the OCS, the Bureau of Ocean Energy Management has been assigned the Federal co-lead, along with the U.S. Coast Guard, for systematic regional planning efforts in the Mid-Atlantic. Additionally, BOEM will participate on Regional Planning Bodies in the Northeast, Mid-Atlantic, and West Coast as the DOI lead. In the Gulf of Mexico OCS Region, BOEM representatives will assist the U.S. Fish and Wildlife Service (FWS), the DOI regional lead, with various working group activities. This will facilitate data and information availability, provide research of new technologies, and identify conflict resolution and avoidance strategies. BOEM anticipates that its Marine Planning engagement will enhance regulatory efficiency through improved coordination and collaboration, and, in the long term, enhance the stewardship of ocean and coastal resources.

These strategies will allow BOEM to not only address the activities that take place under the 2012-2017 Five-Year Program but also to lay the groundwork for decisions that will be faced in subsequent Five-Year Programs. BOEM will improve efforts to gather information while enhancing opportunities for stakeholders and other interested parties to participate in and be engaged in the decisionmaking process. The initiation of studies and long-term planning will facilitate future decisions by ensuring that the best information is available when making leasing decisions on the approved program and before the development of future OCS Programs.

1.5. POSTLEASE ACTIVITIES

BOEM and BSEE are responsible for managing, regulating, and monitoring oil and natural gas exploration, development, and production operations on the Federal OCS to promote the 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 parts 250, 550, 551 (except those aspects that pertain to drilling), and 554.

Measures to minimize potential impacts are an integral part of the OCS Program. These measures are implemented through lease stipulations, operating regulations, and project-specific requirements or approval conditions. Notices to Lessees and Operators (NTL's) provide clarifications and additional information on some of these measures. Mitigating measures address concerns such as endangered and threatened species, geologic and manmade hazards, military warning and ordnance disposal areas, archaeological sites, 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 mitigating measures in the Gulf of Mexico OCS may include the following:

- limiting the size of explosive charges used for structure removals (NTL 2010-G05);
- requiring placement of explosive charges at least 15 ft (5 m) below the mudline;
- requiring site-clearance procedures to eliminate potential snags to commercial fishing nets upon abandonment;
- establishment of No Activity and Modified Activity Zones around high-relief live bottoms;

- requiring remote-sensing surveys to detect and avoid potential archaeological sites and 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.

BOEM issues NTL's to provide clarification, description, or interpretation of a regulation; to provide guidelines on the implementation of a special lease stipulation or regional requirement; or to convey administrative information. A detailed listing of current Gulf of Mexico OCS Region NTL's is available through BOEM's Gulf of Mexico OCS Region's Internet website at http://boem.gov/Regulations/Notices-Letters-and-Information-to-Lessees-and-Operators.aspx or through the Region's Public Information Office at (504) 736-2519 or 1-800-200-GULF.

Formal plans must be submitted to BOEM for review and approval before any project-specific activities, except for ancillary activities (such as geological and geophysical [G&G] activities or studies that model potential oil and hazardous substance spills), can begin on a lease. Conditions of approval, which are mechanisms to control or mitigate potential safety or environmental problems associated with proposed operations, must be met before the activities can be approved by BOEM or BSEE. Conditions of approval are based on BOEM's 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 BOEM-identified mitigating measures are implemented through cooperative agreements or coordination with the oil and gas industry and Federal and State agencies. These measures include the National Marine Fisheries Service's (NMFS's) 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.

Refer to Chapters 1.5 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS for descriptions of postlease activities including G&G surveys; exploration and development plans; permits and applications; inspection and enforcement; pollution prevention, oil-spill response plans, and financial responsibility; air emissions; flaring and venting; hydrogen sulfide contingency plans; archaeological resources regulation; coastal zone management consistency review and appeals for plans; best available and safest technologies, including at production facilities; personnel training and education; structure removal and site clearance; marine protected species NTL's; and the Rigs-to-Reefs program.

1.6. OTHER OCS OIL- AND GAS-RELATED ACTIVITIES

BOEM and BSEE have 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 environmental and technical studies, cooperative agreements with other Federal and State agencies for NEPA work, joint jurisdiction over cooperative efforts, inspection activities, OCS sand borrowing, and regulatory enforcement. BOEM also participates in industry research efforts and forums. Chapter 1.6 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS contain descriptions of the other OCS oil- and gas-related activities, including the Environmental Studies Program, Technology Assessment and Research Program, and interagency agreements.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

2. ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

This Supplemental EIS addresses three proposed Federal actions: proposed oil and gas Lease Sales 235, 241, and 247, in the CPA of the Gulf of Mexico OCS (**Figure 1-1**), as scheduled in the Five-Year Program (USDOI, BOEM, 2012a). The proposed actions (proposed lease sales) assume compliance with applicable regulations and lease stipulations in place at the time a ROD is signed for each proposed action.

2.1. SUPPLEMENTAL EIS NEPA ANALYSIS

Proposed CPA Lease Sales 235, 241, and 247 were analyzed in the 2012-2017 WPA/CPA Multisale EIS. This Supplemental EIS tiers from the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, and it summarizes and hereby incorporates those documents by reference. Each of the proposed lease sales is expected to be within the scenario ranges summarized in **Chapter 3** of this Supplemental EIS and as discussed in Chapter 3 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

Since proposed CPA Lease Sales 235, 241, and 247 and their projected activities are very similar, this Supplemental EIS encompasses the three proposed lease sales as authorized under 40 CFR § 1502.4, which allows related or similar proposals to be analyzed in one EIS. In addition, one Area ID was prepared for the proposed CPA lease sales. The Multisale EIS approach is intended to focus the NEPA/EIS process on the differences between the proposed lease sales and on new issues and information. It also lessens duplication and saves agency resources. At the completion of the NEPA process for this Supplemental EIS, a decision will be made on whether or how to hold proposed CPA Lease Sale 235. An additional NEPA review will be conducted in the year prior to proposed CPA Lease Sales 241 and 247 to address any relevant significant new information. This additional NEPA review could take the form of a determination of NEPA adequacy, an environmental assessment (EA), or if BOEM deems necessary, a supplemental EIS. Informal and formal consultation 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 analysis contained in this Supplemental EIS is still valid. Specifically, information requests will be issued soliciting input on proposed CPA Lease Sales 241 and 247.

This Supplemental EIS analyzes the potential impacts of a CPA proposed action on sensitive coastal environments, offshore marine resources, and socioeconomic resources both onshore and offshore, and it is the final NEPA review conducted for proposed CPA Lease Sale 235. It has been prepared to aid in the determination of whether or not new available information indicates that the proposed lease sales would result in new significant impacts not addressed in the 2012-2017 WPA/CPA Multisale EIS or WPA 233/CPA 231 Supplemental EIS. In preparation for this Supplemental EIS, BOEM utilized the best information available to determine if the baseline condition for resources had changed since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. This best available information was derived from ongoing and past research and from review of peer-reviewed scientific reports and studies, as well as through review of sources open to BOEM's subject-matter experts through Internet searches. Further discussion and analysis of newly identified information and best available information is contained in **Chapters 3 and 4 and in Appendix B**. This Supplemental EIS presents an impartial analysis of this new information.

2.2. ALTERNATIVES, MITIGATING MEASURES, AND ISSUES

2.2.1. Alternatives

The alternatives to be considered for proposed CPA Lease Sales 235, 241, and 247 are detailed in **Chapter 2.3** below. These suggested alternatives have been derived from both the historical comments submitted to BOEM and the EIS-specific scoping performed for this analysis.

Through our scoping efforts for this Supplemental EIS and previous EIS's, numerous issues and topics were identified for consideration. During the scoping period for the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, a number of alternatives or deferral options were suggested and examined for inclusion in those EIS's (Chapter 2.2.1.2 of the 2012-2017 WPA/CPA

Multisale EIS and WPA 233/CPA 231 Supplemental EIS). Those alternative and deferral options were also reexamined during the preparation of this Supplemental EIS. These suggestions included additional deferrals, policy changes, and suggestions beyond the scope of this Supplemental EIS. BOEM has not identified any new significant information that changes its conclusions in the 2012-2017 WPA/CPA Multisale EIS or WPA 233/CPA 231 Supplemental EIS or that indicates that the proposed alternatives or deferral options are not appropriate for further in-depth analysis. The justifications for not carrying those suggestions through detailed analyses in this Supplemental EIS are the same as those used in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The analyses of environmental impacts from the proposed alternatives summarized in **Chapter 2.3.1.2** below and described in detail in **Chapter 4.1.1** 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 **Chapter 3**.

2.2.1.1. Alternatives for Proposed Central Planning Area Lease Sales 235, 241, and 247

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

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006; and

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

The DOI is conservative throughout the NEPA process and includes the total area within the CPA for environmental review even though the leasing of portions of the CPA (subareas or blocks) can be deferred during a Five-Year Program.

The proposed CPA lease sale area encompasses about 63 million ac of the total CPA area of 66.45 million ac. As of February 2014, approximately 43.5 million ac of the proposed CPA lease sale area are unleased. The estimated amount of resources projected to be developed as a result of a proposed CPA lease sale is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas (**Table 3-1**).

Alternative B—The Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks within the proposed CPA lease sale area, as described for the proposed action (Alternative A), but it would exclude from leasing any unleased blocks subject to the Topographic Features Stipulation. The estimated amount of resources projected to be developed is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas (refer to **Chapter 2.3.2** for further details).

Alternative C—No Action: This alternative is the cancellation of a proposed CPA lease sale. If this alternative is chosen, the opportunity for development of the estimated 0.460-0.894 BBO and 1.939-3.903 Tcf of gas that could have resulted from a proposed CPA lease sale would be precluded during the current 2012-2017 Five-Year Program, but it could again be contemplated as part of a future Five-Year Program. Any potential environmental impacts arising out of a proposed CPA lease sale would not occur, but activities associated with existing leases in the CPA would continue. This alternative is also analyzed in the EIS for the Five-Year Program on a nationwide programmatic level.

Alternatives and Deferrals Considered but Not Analyzed in Detail

Chapter 2.2.1.2 of the 2012-2017 WPA/CPA Multisale EIS includes a detailed description of alternatives considered but not analyzed in this Supplemental EIS, including the following: exclude deep water and limit leasing to shallow waters; delay leasing until drilling safety is improved; do not allow drilling in areas with strong ocean currents such as the Loop Current; delay leasing until the state of the Gulf of Mexico environmental baseline is known; and identify and protect sensitive ecosystems. The justifications for not engaging in detailed analysis of these alternatives and deferrals in this Supplemental

EIS are the same as those used in the 2012-2017 WPA/CPA Multisale EIS, and BOEM has identified no new information that changes these conclusions.

2.2.2. Mitigating Measures

The NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences and to take actions that protect, restore, and enhance the environment. Agencies are required to identify and include in the alternative chosen relevant and reasonable mitigating measures and lease stipulations that could improve the action. The CEQ regulations (40 CFR § 1508.20) define mitigation as follows:

- Avoidance—Avoiding an impact altogether by not taking a certain action or part of an action.
- Minimization—Minimizing impacts by limiting the intensity or magnitude of the action and its implementation.
- Restoration—Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Maintenance—Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensation—Compensating for the impact by replacing or providing substitute resources or environments.

2.2.2.1. Proposed Mitigating Measures Analyzed

The potential lease stipulations and mitigating measures included for analysis in this Supplemental EIS were developed as a result of numerous scoping efforts for the continuing OCS Program in the Gulf of Mexico. Ten lease stipulations (described in Chapter 2.4.1.3 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS) are proposed for CPA Lease Sales 235, 241, and 247—the Topographic Features Stipulation; the Live Bottom (Pinnacle Trend) Stipulation; the Military Areas Stipulation; the Evacuation Stipulation; the Coordination Stipulation; the Blocks South of Baldwin County, Alabama, Stipulation; the Protected Species Stipulation; the Law of the Sea Convention Royalty Payment Stipulation; the Below Seabed Operations Stipulation; the Transboundary Stipulation. The Law of the Sea Convention Royalty Payment Stipulation is applicable to a proposed CPA lease sale even though it is not an environmental or military stipulation.

These measures will be considered for adoption by the ASLM, under authority delegated by the Secretary of the Interior. The analysis of any stipulations for Alternative A does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from a proposed CPA 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 lease stipulations or mitigating measures to be included in a lease sale will be described in the ROD for that lease sale. Mitigating 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 result from a lease sale, will undergo a NEPA review and additional project-specific mitigations applied as conditions of plan approval. The BSEE has the authority to monitor and enforce these conditions and, under 30 CFR part 250 subpart N, may seek remedies and penalties from any operator that fails to comply with those conditions, stipulations, and mitigating measures.

2.2.2.2. Existing Mitigating Measures

Mitigating measures have been proposed, identified, evaluated, or developed through previous BOEM 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 (e.g., exploration and development plans, pipeline applications, and structure-removal applications) go through rigorous BOEM review and approval to ensure compliance with established laws and regulations. Existing mitigating measures must be incorporated and documented in plans submitted to BOEM. Operational compliance of the mitigating measures is enforced through BSEE's onsite inspection program.

Mitigating measures are a standard part of BOEM's program to ensure that the operations are always conducted in an environmentally sound manner (with an emphasis on minimizing any adverse impact of routine operations on the environment). For example, certain measures ensure site clearance, and survey procedures are carried out to determine potential snags to commercial fishing gear and to avoid archaeological sites and biologically sensitive areas such as pinnacles, topographic features, and chemosynthetic communities.

Some BOEM-identified mitigating measures are incorporated into OCS operations through cooperative agreements or efforts with industry and State and Federal agencies. These mitigating measures include mandating compliance with NMFS's Observer Program to protect marine mammals and sea turtles during the use of explosives for structure removal, labeling operational supplies to track possible sources of debris or equipment loss, developing methods of pipeline landfall to eliminate impacts to beaches or wetlands, and requiring beach cleanup events.

Site-specific mitigating measures are also applied by BOEM during plan and permit reviews. BOEM realized that many of these site-specific mitigations were recurring and developed a list of "standard" mitigations. There are currently over 120 standard mitigations. The wording of a standard mitigation is developed by BOEM in advance and may be applied whenever conditions warrant. Standard mitigation text is revised as often as is necessary (e.g., to reflect changes in regulatory citations, agency/personnel contact numbers, and internal policy). Site-specific mitigation "categories" include the following: air quality; archaeological resources; artificial reef material; chemosynthetic communities; Flower Garden Banks; topographic features; hard bottom/pinnacles, military warning areas and Eglin water test areas; hydrogen sulfide; drilling hazards; remotely operated vehicle surveys; geophysical survey reviews; and general safety concerns. Site-specific mitigation "types" include the following: advisories; conditions of approval; hazard survey reviews; inspection requirements; notifications; post-approval submittals; and safety precautions. In addition to standard mitigations, BOEM may apply nonrecurring mitigating measures that are developed on a case-by-case basis.

BOEM is continually revising applicable mitigations to allow the Gulf of Mexico OCS Region to more easily and routinely track mitigation compliance and effectiveness. A primary focus of this effort is requiring post-approval submittal of information within a specified timeframe or after a triggering event (e.g., end of operations reports for plans, construction reports for pipelines, and removal reports for structure removals).

2.2.3. Issues

Issues are defined in CEQ Guidance as the principal "effects" that an EIS should evaluate in-depth. Selection of environmental and socioeconomic issues to be analyzed was based on the following criteria:

- the issue is identified in CEQ regulations as subject to evaluation;
- the relevant resource/activity was identified through agency expertise, 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 associated with the OCS Program; a reasonable probability of an interaction between the resource/activity and impact-producing factor should exist; or
- the 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

Chapter 2.2.3.1 of the 2012-2017 WPA/CPA Multisale EIS addresses the issues related to potential impact-producing factors and the environmental and socioeconomic resources and activities that could be affected by OCS exploration, development, production, and transportation activities (i.e., accidental events, drilling fluids and cuttings, visual and aesthetic interference, air emissions, water quality degradation and other wastes, structure and pipeline emplacement, platform removals, OCS-related support services, activities, and infrastructure, socio-cultural and socioeconomic, and OCS oil and gas infrastructure). Chapter 4.2 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, and **Chapter 4.1** of this Supplemental EIS describe the resources and activities that could be affected by the impact-producing factors listed above and include 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
- Deepwater Benthic Communities (Chemosynthetic and Nonchemosynthetic)
- Diamondback Terrapins
- Fish Resources and Essential Fish Habitat
- Gulf Sturgeon
- Human Resources and Land Use (Land Use and Coastal Infrastructure, Demographics, Economic Factors, and Environmental Justice)
- Live Bottoms (Pinnacle Trend and Low Relief)
- Marine Mammals
- Recreational Fishing
- Recreational Resources
- *Sargassum* Communities
- Sea Turtles
- Seagrass Communities
- Soft Bottom Benthic Communities
- Topographic Features
- Water Quality (Coastal and Offshore)
- Wetlands

2.2.3.2. Issues Considered but Not Analyzed

As previously noted, the CEQ 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 a CPA proposed action or have been covered by prior environmental review. No additional issues were identified during scoping that are not addressed in this Supplemental EIS. Comments received during scoping are summarized in **Chapter 5.3**.

2.3. PROPOSED CENTRAL PLANNING AREA LEASE SALES 235, 241, AND 247

2.3.1. Alternative A—The Proposed Action (Preferred Alternative)

2.3.1.1. Description

Alternative A would offer for lease all unleased blocks within the proposed CPA lease sale area for oil and gas operations (**Figure 2-1**), with the following exception:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006; and

(2) blocks that are adjacent to or beyond the United States Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

The DOI is conservative throughout the NEPA process and includes the total area within the CPA for environmental review even though the leasing of portions of the CPA (subareas or blocks) can be deferred during a Five-Year Program.

The proposed CPA lease sale area encompasses about 63 million ac of the total CPA area of 66.45 million ac. As of February 2014, approximately 43.5 million ac of the proposed CPA lease sale area are currently unleased. The estimated amount of resources projected to be developed as a result of a proposed CPA lease sale is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas (**Table 3-1**).

The analyses of impacts summarized below and described in detail in **Chapter 4.1.1** 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 **Chapter 3**.

Alternative A has been identified as BOEM's preferred alternative; however, this does not mean that another alternative may not be selected in the Record of Decision.

2.3.1.2. Summary of Impacts

A search by BOEM's subject-matter experts was conducted for each resource to consider new information made available since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS and to consider new information on the *Deepwater Horizon* explosion, oil spill, and response. It must also be emphasized that, in arriving at the overall conclusions for certain environmental resources (e.g., coastal and marine birds, fisheries, and wetlands), the conclusions are not based on impacts to individuals, small groups of animals, or small areas of habitat, but on impacts to the resources/populations as a whole. Any new information discovered was analyzed by BOEM's subject-matter experts to determine if the impact conclusions presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS were altered as a result of the new information.

For the following resources, BOEM's subject-matter experts determined through literature searches and communications with other agencies and academia that there was no new information made available since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS that was relevant to potential impacts from a CPA proposed action. Therefore, the impact conclusions for these resources remain the same as those that were presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. These impact conclusions are presented in **Chapter 4.1.1** of this Supplemental EIS. For ease of review, the individual chapter numbers for each resource are provided in the following list.

- Air Quality (**Chapter 4.1.1.1**)
- Water Quality (Coastal and Offshore Waters) (**Chapters 4.1.1.2.1 and 4.1.1.2.2**, respectively)
- Coastal Barrier Beaches and Associated Dunes (**Chapter 4.1.1.3**)
- Seagrass Communities (**Chapter 4.1.1.5**)
- Live Bottoms (Pinnacle Trend and Low Relief) (**Chapter 4.1.1.6**)
- Topographic Features (**Chapter 4.1.1.7**)
- *Sargassum* Communities (**Chapter 4.1.1.8**)
- Chemosynthetic Deepwater Benthic Communities (**Chapter 4.1.1.9**)
- Nonchemosynthetic Deepwater Benthic Communities (**Chapter 4.1.1.10**)
- Soft Bottom Benthic Communities (**Chapter 4.1.1.11**)
- Gulf Sturgeon (**Chapter 4.1.1.17**)
- Fish Resources and Essential Fish Habitat (**Chapter 4.1.1.18**)
- Species Considered due to U.S. Fish and Wildlife Service Concerns (**Chapter 4.1.1.24**)

For the following resources, BOEM's subject-matter experts determined through literature searches and communications with other agencies and academia that there was new information made available since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS that was relevant to potential impacts from a CPA proposed action. BOEM's subject-matter experts have reexamined the analyses for these resources based on new information made available; however, none of the new information was deemed significant in that it did not alter of the impact conclusions presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. These impact conclusions are presented in **Chapter 4.1.1**. For ease of review, the individual chapter numbers for each resource are provided in the following list.

- Wetlands (**Chapter 4.1.1.4**)
- Marine Mammals (**Chapter 4.1.1.12**)
- Sea Turtles (**Chapter 4.1.1.13**)
- Diamondback Terrapins (**Chapter 4.1.1.14**)
- Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice (**Chapter 4.1.1.15**)
- Coastal and Marine Birds (**Chapter 4.1.1.16**)
- Commercial Fisheries (**Chapter 4.1.1.19**)
- Recreational Fishing (**Chapter 4.1.1.20**)
- Recreational Resources (**Chapter 4.1.1.21**)
- Archaeological Resources (Historic and Prehistoric) (**Chapters 4.1.1.22.1 and 4.1.1.22.2**, respectively)
- Human Resources and Land Use (Land Use and Coastal Infrastructure, Demographics, Economic Factors, and Environmental Justice) (**Chapters 4.1.1.23.1, 4.1.1.23.2, 4.1.1.23.3, and 4.1.1.23.4**, respectively)

Ultimately, no new significant information was discovered that would alter the impact conclusions for any of the resources analyzed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analyses and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS remain valid and, as such, apply for proposed CPA Lease Sales 235, 241, and 247.

In accordance with CEQ recommendations to provide decisionmakers with a robust environmental analysis, **Appendix B** ("Catastrophic Spill Event Analysis") provides an analysis of the potential impacts of a low-probability, catastrophic oil spill, which is not reasonably expected and not part of a CPA proposed action, to the environmental and cultural resources and the socioeconomic conditions analyzed in **Chapter 4.1.1**

2.3.1.3. Mitigating Measures

2.3.1.3.1. Topographic Features Stipulation

The topographic features located in the CPA provide habitat for coral-reef-community organisms (**Chapter 4.1.1.7**). These communities could be severely and adversely impacted by oil and gas activities resulting from a CPA proposed action 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, has made lease stipulations 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. This stipulation has been updated over time, using years of scientific information collected since the stipulation was first proposed. This information includes numerous Agency-funded studies of topographic features 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). This stipulation protects these biotic communities from routine oil and gas activities resulting from a CPA proposed action, while allowing the development of nearby oil and gas resources. This stipulation would not prevent adverse effects of an accident such as a large blowout on a nearby oil or gas operation from impacting these biotic communities. The location of the blocks affected by the Topographic Features Stipulation is shown on **Figure 2-1**. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.4.1.3.1 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.2. Live Bottom (Pinnacle Trend) Stipulation

The Live Bottom (Pinnacle Trend) Stipulation covers the pinnacle trend area of the proposed CPA lease sale area. A small portion of the northeastern proposed CPA lease 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 4.1.1.6**. 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 location of the pinnacle trend areas of the proposed CPA lease sale area is shown on **Figure 2-1**. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.4.1.3.2 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.3. Military Areas Stipulation

The Military Areas Stipulation has been applied to all blocks leased in military areas since 1977 and reduces potential impacts, particularly in regards to safety. However, this stipulation does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The stipulation contains a "hold harmless" clause (holding the U.S. Government harmless in case of an accident involving military operations) and requires lessees to coordinate their activities with appropriate local military contacts. **Figure 2-2** shows the military warning areas in the Gulf of Mexico. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.3.1.3.2 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.4. Evacuation Stipulation

The Evacuation Stipulation would be a part of any lease in the easternmost portion of the proposed CPA lease sale area resulting from a CPA proposed action, i.e., Lease Sales 235, 241, and 247. 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 BSEE and the military may result in improvements in the wording and implementation of these stipulations.

An evacuation stipulation has been applied to all blocks leased in this area since 2001. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.4.1.3.4 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.5. Coordination Stipulation

The Coordination Stipulation would be a part of any lease in the easternmost portion of the proposed CPA lease sale area resulting from a CPA proposed action, i.e., Lease Sales 235, 241, and 247. 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.

A coordination stipulation has been applied to all blocks leased in this area since 2001. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.4.1.3.5 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.6. Blocks South of Baldwin County, Alabama, Stipulation

The Blocks South of Baldwin County, Alabama, Stipulation will be included only on leases on blocks south of and within 15 mi (24 km) of Baldwin County, Alabama. The stipulation specifies requirements for consultation that lessees must follow when developing plans for fixed structures. The stipulation has been continually adopted in annual CPA lease sales since 1999. It has been considered satisfactorily responsive to the concern of the Governor of Alabama and was adopted in each of the CPA lease sales in the 2002-2007 and 2007-2012 Five-Year Programs. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.4.1.3.6 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.7. Protected Species Stipulation

The Protected Species Stipulation has been applied to all blocks leased in the GOM since December 2001. This stipulation was developed in consultation with the Department of Commerce, National Oceanic and Atmospheric Administration, NMFS and the Department of the Interior, FWS in accordance with section 7 of the Endangered Species Act, and it is designed to minimize or avoid potential adverse impacts to federally protected species. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.3.1.3.3 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.8. Law of the Sea Convention Royalty Payment Stipulation

The Law of the Sea Convention Royalty Payment Stipulation applies to blocks or portions of blocks beyond the U.S. Exclusive Economic Zone (generally greater than 200 nmi [230 mi; 370 km] from the U.S. coastline). Leases on these blocks may be subject to special royalty payments under the provisions of the 1982 Law of the Sea Convention (consistent with Article 82), if the U.S. becomes a party to the Convention prior to or during the life of the lease. A more detailed discussion and definition of this stipulation and its effectiveness are found in Chapter 2.3.1.3.4 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.9. Below Seabed Operations Stipulation

The Below Seabed Operations Stipulation language is intended to be lease sale-specific language and would incorporate maps of the blocks that may be affected. This stipulation can be found in Chapter 2.4.1.3.9 of the 2012-2017 WPA/CPA Multisale EIS.

2.3.1.3.10. Transboundary Stipulation

The "Agreement Between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico," once it enters into force, will make it possible for U.S. lessees to enter into voluntary agreements with a licensee of the United Mexican States to develop transboundary reservoirs. The stipulation applies to blocks or portions of blocks located wholly or partially within the 3 statute miles (4.8 km) of the maritime or continental shelf boundary with Mexico. The stipulation incorporates by reference the Transboundary Agreement and notifies lessees that, among other things, activities in this boundary area will be subject to the Agreement and that approval of plans, permits, and unitization agreements will be conditioned upon compliance with the terms of the Agreement. For more information, refer to the Transboundary Agreement available at http://www.boem.gov/BOEM-Newsroom/Library/Publications/Agreement-between-the-United-States-and-Mexico-Concerning-Transboundary-Hydrocarbon-Reservoirs-in-the-Gulf-of-Mexico.aspx.

2.3.2. Alternative B—The Proposed Action 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 potentially subject to the proposed Topographic Features Stipulation (Chapter 2.4.1.3.1 of the 2012-2017 WPA/CPA Multisale EIS and **Figure 2-1** of this Supplemental EIS**)**. All other assumptions (including the 9 other potential mitigating measures and the 1 stipulation) and estimates are the same as for Alternative A. The estimated amount of resources projected to be developed is 0.460-0.894 BBO and 1.939-3.903 Tcf of gas.

2.3.2.2. Summary of Impacts

The analyses of impacts summarized in **Chapter 2.3.1.2** and described in detail in **Chapter 4.1.1** 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 **Chapter 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 number of blocks that would not be offered under Alternative B represents only a small percentage of the total number of blocks to be offered under Alternative A; therefore, it is assumed that the levels of activity for Alternative B would be similar to those projected for a CPA proposed action. As a result, the impacts expected to result from Alternative B would be very similar to those described under a CPA proposed action (**Chapter 4.1.1**). Regional impact levels for all resources, except for the topographic features, would be similar to those described under a CPA proposed action. 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.

2.3.3. Alternative C—No Action

2.3.3.1. Description

Alternative C is the cancellation of a proposed CPA lease sale. If this alternative is chosen, the opportunity for development of the estimated 0.460-0.894 BBO and 1.939-3.903 Tcf of gas that could have resulted from a proposed CPA lease sale would be precluded or postponed to a future CPA lease sale. Any potential environmental impacts arising out of a proposed CPA lease sale would not occur, but activities associated with existing leases in the CPA would continue. The No Action alternative, therefore, encompasses the same potential impacts as a decision to delay the leasing of unleased blocks in the CPA to a later scheduled lease sale under the Five-Year Program, when another decision on whether to hold that future lease sale would be made. Because delay of a proposed CPA lease sale would yield essentially the same results as the No Action alternative (i.e., most impacts related to Alternative A would not occur), delay of a proposed lease sale was not considered as a separate alternative under this Supplemental EIS.

2.3.3.2. Summary of Impacts

Canceling a proposed CPA lease sale would eliminate the effects described for Alternative A (**Chapter 4.1.3**). The incremental contribution of a proposed lease sale to the cumulative effects would also be foregone, but the effects from other activities, including other previous OCS lease sales, would remain. Moreover, if a proposed CPA lease sale was canceled, the resulting development of oil and gas could be reevaluated under a future proposed lease sale. Therefore, the overall level of OCS activity in the CPA would only be reduced by a small percentage, if any, and the cancellation of a proposed CPA lease sale would not significantly change the environmental impacts of overall OCS activity in the short term at least. However, the cancellation of a proposed CPA lease sale could result in direct economic impacts to the individual companies. Revenues collected by the Federal Government (and thus revenue disbursements to the States) also would be adversely affected.

If a proposed CPA lease sale was canceled, then other sources of energy could potentially be substituted 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. For example, the tankering of fuels from alternate sources over longer distances may have significant potential negative impacts, including the increased risk of spills in the Gulf of Mexico.

CHAPTER 3

IMPACT-PRODUCING FACTORS AND SCENARIO

3. IMPACT-PRODUCING FACTORS AND SCENARIO

3.1. IMPACT-PRODUCING FACTORS AND SCENARIO—ROUTINE OPERATIONS

3.1.1. Offshore Impact-Producing Factors and Scenario

Chapter 3.1.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 3.1.1 of the WPA 233/ CPA 231 Supplemental EIS describe in detail the offshore infrastructure and activities (impact-producing factors) associated with a CPA proposed action (i.e., a typical lease sale that would result from a proposed action) within the CPA that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico. In addition, Chapter 3.1.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 3.1.1 of the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2014 and 2016; Eastern Planning Area Lease Sales 225 and 226; Final Environmental Impact Statement* (EPA 225/226 EIS) (USDOI, BOEM, 2013b) also describe the OCS Program's cumulative activity scenario resulting from past and future lease sales in the WPA, CPA, and EPA that could potentially affect the biological, physical, and socioeconomic resources of the GOM within the CPA. Note that offshore and onshore impact-producing factors and scenarios associated with a WPA or an EPA proposed action (i.e., a typical lease sale that would result from a proposed action within the WPA or EPA) as well as OCS Program activity resulting from past and future lease sales in the WPA or EPA are disclosed in the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, WPA 238/246/248 Supplemental EIS (*Gulf of Mexico OCS Oil and Gas Lease Sales: 2014-2016; Western Planning Area Lease Sales 238, 246, and 248; Final Environmental Impact Statement*), and EPA 225/226 EIS.

Offshore is defined, for the purposes of this Supplemental EIS, as the OCS portion of the GOM that begins 3 marine leagues (9 nmi; 10.36 mi; 16.67 km) offshore Texas and Florida and 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama. The OCS extends seaward to the limits of the United States' jurisdiction over the continental shelf in water depths up to approximately 3,346 m (10,978 ft), which comprises the Exclusive Economic Zone (**Figure 1-1**). Coastal infrastructure and activities associated with a CPA proposed action are described in **Chapter 3.1.2** of this Supplemental EIS and in Chapter 3.1.2 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

BOEM projects that the overwhelming majority of the oil and natural gas fields discovered as a result of a CPA proposed action will reach the end of their economic life within a time span of 40 years following a lease sale. Therefore, activity levels are projected to 40 years for this Supplemental EIS. Although unusual cases exist where activity on a lease may continue beyond 40 years, BOEM's forecasts indicate that most significant activities associated with exploration, development, production, and abandonment of leases in the GOM occur well within the 40-year analysis period. For the cumulative case analysis, total OCS Program exploration and development activities are also forecast over a 40-year period. For modeling purposes and quantitative OCS Program activity analyses, a 40-year analysis period is also used. Exploration and development activity forecasts become increasingly more uncertain as the length of time of the forecast increases and the number of influencing factors increases.

BOEM uses a series of spreadsheet-based data analysis tools to develop the forecasts of oil and gas exploration, discovery, development, and production activity for a proposed action and OCS Program scenarios presented in this Supplemental EIS. BOEM's analyses incorporate all relevant historical activity and infrastructure data, and BOEM's resulting forecasts are analyzed and compared with actual historical data to ensure that historical precedent and recent trends are reflected in each activity forecast.

BOEM is confident that its analysis methodology, with adjustments and refinements based on recent activity levels, adequately projects Gulf of Mexico OCS activities in both the short term and the long term for the EIS analyses.

The CPA proposed actions and the Gulfwide OCS Program scenarios are based on the following factors:

- resource estimates developed by BOEM;
- recent trends in the amount and location of leasing, exploration, and development activity;

- estimates of undiscovered, unleased, economically recoverable oil and gas resources in each water-depth category and each planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- published data and information;
- industry information; and
- oil and gas technologies, and the economic considerations and environmental constraints of these technologies.

Proposed CPA Lease Sales 235, 241, and 247 each represent 3-4 percent of the OCS Program activities expected in the CPA from 2012 through 2051 based on barrels of oil equivalent (BOE) resource estimates and 2.5-3.5 percent of the total OCS Program (WPA, CPA, and EPA) from 2012 through 2051.

Specific projections for activities associated with a CPA proposed action are discussed in the following scenario sections. The potential impacts of the activities associated with a proposed "typical" CPA lease sale are considered in the environmental analysis sections (**Chapter 4.1.1** of this Supplemental EIS and Chapter 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS).

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 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 sections (**Chapter 4.1.1** of this Supplemental EIS and Chapter 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS).

3.1.1.1. Resource Estimates and Timetables

The CPA proposed actions and cumulative cases have not changed since last analyzed for the 2012-2017 WPA/CPA Multisale EIS. BOEM has not identified any new information or change in circumstances since publication of the 2012-2017 WPA/CPA Multisale EIS or WPA 233/CPA 231 Supplemental EIS that would change the estimates and timetables.

3.1.1.1.1. Proposed Action

The proposed action scenario is used to assess the potential impacts of a proposed "typical" 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 area; 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. 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. 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. Historical databases and information derived from oil and gas exploration and development activities are available to BOEM 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 a typical lease sale held as a result of a proposed action based on an actual range of historic observations.

Table 3-1 presents the projected oil and gas production for a CPA proposed action and for the OCS Program. **Table 3-2** provides a summary of the major scenario elements of a CPA proposed action, a "typical" lease sale, and related impact-producing factors. To analyze impact-producing factors for a CPA proposed action and the OCS Program, the proposed CPA lease sale area was divided into offshore subareas based upon ranges in water depth. **Figure 3-1** 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 (CPA Typical Lease Sale): The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a typical proposed CPA lease sale are 0.460-0.894 BBO and 1.939-3.903 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 CPA proposed action is given in **Table 3-2**. The table shows the distribution of these factors by offshore subareas in the proposed lease sale area. **Table 3-2** includes estimates of the major impact-producing factors related to the projected levels of exploration, development, and production activity.

Exploratory drilling activity generally takes place over an 8-year period, beginning within 1 year after a lease sale. Development activity generally 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 a lease sale and would likely conclude by year 40; however, in rare cases, production could continue beyond year 40.

3.1.1.1.2. OCS Program

OCS Program Cumulative Scenario (WPA, CPA, and EPA): Projected reserve/resource production for the OCS Program is 18.335-25.64 BBO and 75.886-111.627 Tcf of gas and represents anticipated production from lands currently under lease plus anticipated production from future lease sales over the 40-year analysis period. The OCS Program cumulative scenario includes WPA, CPA, and EPA production estimates. **Table 3-3** presents all anticipated production from lands currently under lease in the WPA, CPA, and EPA plus all anticipated production from future total OCS Program (WPA, CPA, and EPA) lease sales over the 40-year analysis period.

WPA Cumulative Scenario: Projected reserve/resource production for the OCS Program in the WPA (2.510-3.696 BBO and 12.539-18.434 Tcf of gas) represents anticipated production from lands currently under lease in the WPA plus anticipated production from future WPA lease sales over the 40-year analysis period. Projected production under the cumulative scenario represents approximately 14 percent of the oil and 17 percent of the gas of the total Gulfwide OCS Program. Table 3-4 of the WPA 238/246/248 Supplemental EIS presents all anticipated production from lands currently under lease in the WPA plus all anticipated production from future WPA lease sales over the 40-year analysis period. The impact-producing factors, affected environment, and environmental consequences related to WPA proposed lease sales are disclosed in the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, and WPA 238/246/248 Supplemental EIS.

CPA Cumulative Scenario: Projected reserve/resource production for the OCS Program in the CPA (15.825-21.733 BBO and 63.347-92.691 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 under the cumulative scenario represents approximately 85-86 percent of the oil and 83 percent of the gas of the total Gulfwide OCS Program. **Table 3-4** presents all anticipated production from lands currently under lease in the CPA plus all anticipated production from future CPA lease sales over the 40-year analysis period. The impact-producing factors, affected environment, and environmental consequences related to CPA proposed lease sales are disclosed in this Supplemental EIS, the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

EPA Cumulative Scenario: Projected reserve/resource production for the OCS Program in the EPA (0-0.211 BBO and 0-0.502 Tcf of gas) represents all anticipated production from lands currently under lease in the EPA plus all anticipated production from future EPA lease sales over the 40-year analysis period. Projected production represents approximately 1 percent of the oil and <1 percent of the gas of the total Gulfwide OCS Program. Table 3-3 in the EPA 225/226 EIS presents all anticipated production from lands currently under lease in the EPA plus all anticipated production from future EPA lease sales over the 40-year analysis period. The impact-producing factors, affected environment, and environmental consequences related to EPA proposed lease sales are disclosed in the EPA 225/226 EIS.

3.1.1.2. Exploration and Delineation

3.1.1.2.1. Seismic Surveying Operations

Chapter 3.1.1.2.1 of the 2012-2017 WPA/CPA Multisale EIS describes in detail seismic survey operations including ocean-bottom surveys.

Prelease surveys are comprised of seismic work performed on or off leased areas, focused most commonly (but not always) on deeper targets and collectively authorized under BOEM's geological and geophysical permitting process. Postlease, high-resolution seismic surveys collect data on surficial or near-surface geology used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. 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. These noise sources are discussed in **Chapter 3.1.1.6** of this Supplemental EIS and in Chapter 3.1.1.6 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS).

CPA Proposed Action Scenario (Typical Lease Sale): Because of the cyclic nature in the acquisition of seismic surveys, a prelease seismic survey would be attributable to lease sales held up to 7-9 years after the survey. Based on an amalgam of historical trends in G&G permitting and industry input, BOEM projects that proposed lease sales within the EPA, WPA, and CPA would result in 29,197 OCS blocks surveyed by 2D and 3D deep seismic operations for the years 2012-2017. Broken down per planning area, this yields approximately 21,314 blocks in the CPA, approximately 7,300 blocks in the WPA, and approximately 583 blocks in the EPA. It should be noted that the number of blocks could include multiple surveys on a single block that would then be counted each time as a unique block survey. For postlease seismic surveys, information obtained from high-resolution seismic contractors operating in the GOM project the proposed actions would result in about 50 vertical seismic profiling (VSP) operations and 629 high-resolution surveys covering approximately 226,400 line miles (364,420 km) of near-surface and shallow penetration seismic during the life of the proposed actions. The impact-producing factors, affected environment, and environmental consequences related to CPA proposed lease sales are disclosed and addressed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

OCS Program Cumulative Scenario: Seismic surveys are projected to follow the same trend as exploration activities, which peaked in 2008-2010, will steadily decline until 2027, and will remain relatively steady throughout the second half of the 40-year analysis period. It is important to note that the cycling of G&G data acquisition is not driven by the 40-year life cycle of productive leasing, but instead will trend to respond to new production or potential new production driven by new technology. Consequently, some areas will be resurveyed in 2-year cycles, while other areas, considered nonproductive, may not be surveyed for 20 years or more.

Assuming that acoustic-sourced seismic will remain the dominant exploration tool used by industry in the future and that a number of surveyed blocks will be resurveying several more times, BOEM makes the following projections. During the first 5 years (2012-2017) of the analysis period (2012-2051), BOEM projects the following annual activities: 50 VSP operations; 226,400 lines miles (364,420 km) surveyed by high-resolution seismic; and 29,197 blocks surveyed by deep seismic, including areas that will be resurveyed. Expanding this analysis to the first 20 years (2012-2032), the annual projections would be 60 VSP operations, 400,000 mi (740,800 km) of high-resolution seismic, and 33,000 blocks of 2D/3D deep seismic (10% in EPA, 60% in CPA, and 30% in WPA). During the second half of the 40-year analysis period, the annual projection would be approximately 40 VSP operations, 240,000 mi (444,480 km) surveyed by high-resolution seismic, and 15,000-20,000 blocks surveyed by deep seismic (50% in the CPA, 30% in the WPA, and 20% in the EPA).

3.1.1.2.2. Exploration and Delineation Plans and Drilling

Chapter 3.1.1.2.2 of the 2012-2017 WPA/CPA Multisale EIS describes in detail 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 confirm that a resource exists. If a resource is discovered in quantities appearing to be economically viable and in circumstances when reservoirs are large, one or more follow-up delineation wells help define the amount of resource or the extent of the reservoir. Following a discovery, an operator will often temporarily plug and abandon a discovery to allow time to generate a development scenario and to build or procure equipment.

In the GOM, exploration and delineation wells are typically drilled with mobile offshore drilling units (MODU's); e.g., jack-up rigs, semisubmersible rigs, submersible rigs, platform rigs, or drillships. Non-MODU, such as inland barges, are also used. 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 rig availability and daily operation rates play a large role when an operator decides upon the type of rig to contract. The depth ranges for exploration rigs used in this analysis for Gulf of Mexico MODU's are indicated below.

MODU or Drilling Rig Type	Water-Depth Range
Jack-up, submersible, and inland barges	≤100 m (328 ft)
Semisubmersible and platform rig	100-3,000 m (328-9,843 ft)
Drillship	≥600 m (1,969 ft)

Historically, drilling rig availability has been a limiting factor for activity in the GOM and is assumed to be a limiting factor for activity projected as a result of a proposed lease sale. Drilling activities may also be constrained by the availability of rig crews, shore-based facilities, risers, and other equipment.

The scenario for a CPA proposed action assumes that an average exploration well will require 30-120 (mean of 60) 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 4,572-7,010 m (15,000-23,000 ft) below the mudline (i.e., surface of the seafloor).

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 average exploration well can be $40-$150 million or more, without certainty that objectives can be reached (i.e., an actual discovery and/or confirmation of hydrocarbons). Some recent ultra-deepwater exploration wells (>6,000 ft [1,829 m] water depth) in the GOM have been reported to cost upwards of $200 million. The actual cost 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.

Subpart D of BSEE's regulations (30 CFR part 250) specifies requirements for drilling activities. Refer to **Chapter 1.3.1** of this Supplemental EIS, Chapter 1.3.1 and Table 1-2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 1.3.2 of the WPA 233/CPA 231 Supplemental EIS, which provide a summary of new and updated safety requirements.

Tables 3-2 through 3-4 show the estimated range of exploration and delineation wells by water-depth range for the CPA typical lease sale cases; WPA, CPA, and EPA total OCS Program case; and CPA cumulative cases, respectively.

CPA Proposed Action Scenario (Typical Lease Sale): BOEM estimates that 168-329 exploration and delineation wells would be drilled as a result of the CPA proposed action. **Table 3-2** shows the estimated range of exploration and delineation wells by water-depth range. Greater than 50 percent of the projected wells for the CPA proposed action are expected to be on the continental shelf (0-200 m [0-656 ft] water depth), and fewer than 50 percent are expected in intermediate water-depth ranges and deeper (>200 m; 656 ft).

OCS Program Cumulative Scenario (WPA, CPA, and EPA): BOEM estimates that 6,910-9,827 exploration and delineation wells would be drilled in the WPA, CPA, and EPA as a result of all past OCS lease sales and projected activity for future lease sales associated with this Five-Year Program. **Tables 3-3 and 3-4** of this Supplemental EIS and Table 3-6 of the 2012-2017 WPA/CPA Multisale EIS show the estimated range of exploration and delineation wells by water-depth range. Of these wells, approximately 55 percent are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and approximately 45 percent are expected in intermediate water-depth ranges and deeper (>200 m; 656 ft). Note that offshore and onshore impact-producing factors and scenarios associated with a WPA or an EPA proposed action (i.e., a typical lease sale that would result from a proposed action within the WPA or EPA), as well as OCS Program activity resulting from past and future lease sales in the WPA or EPA are disclosed in the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, WPA 238/246/248 Supplemental EIS, and EPA 225/226 EIS.

3.1.1.3. Development and Production

Development and Production Drilling

Chapter 3.1.1.3.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS describe in detail development and production drilling and development operations and coordination documents.

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 results in 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. BOEM estimates that approximately 90 percent of development wells will 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 "fracking." Fracking 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.

The chief planning document that lays out an operator's specific intentions for development is the development operations coordination document (DOCD). The range of postlease development plans is discussed in Chapter 1.5 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. **Table 3-2** shows the estimated range of development wells and production structures by water-depth subarea for a CPA proposed action.

CPA Proposed Action Scenario (Typical Lease Sale): It is estimated that 215-417 development and production wells will be drilled as a result of a CPA proposed action. **Table 3-2** shows the estimated range of development and production wells by water-depth subarea. The percentage of projected oil wells within the CPA is more evenly distributed throughout the water-depth ranges, with the greatest number of wells being forecasted for water depths >2,400 m (7,874 ft), whereas 66-75 percent of the gas wells are projected to be drilled on the continental shelf (0-200 m [0-656 ft] water depth).

OCS Program Cumulative Scenario (WPA, CPA, and EPA): It is estimated that 8,530-12,180 development and production wells will be drilled in the WPA, CPA, and EPA as a result of the proposed lease sales and all OCS activity associated with previous lease sales. **Table 3-3** shows the estimated range of development wells by water depth.

Note that offshore and onshore impact-producing factors and scenarios associated with a WPA or an EPA proposed action (i.e., a typical lease sale that would result from a proposed action within the WPA or EPA as well as OCS Program activity resulting from past and future lease sales in the WPA or EPA) are disclosed in the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, WPA 238/246/248 Supplemental EIS, and EPA 225/226 EIS.

Infrastructure Emplacement/Structure Installation and Commissioning Activities

Chapter 3.1.1.3.2 of the 2012-2017 WPA/CPA Multisale EIS describes in detail 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.

CPA Proposed Action Scenario (Typical Lease Sale): It is estimated that 35-67 production structures will be installed as a result of a CPA proposed action. **Table 3-2** shows the projected number of structure installations for a CPA proposed action by water-depth range. About 80 percent of all the production structures installed for a CPA proposed action are projected to be on the continental shelf (0-60 m; 0-197 ft).

OCS Program Cumulative Scenario (WPA, CPA, and EPA): It is estimated that 1,435-2,026 production structures would be installed in the WPA, CPA, and EPA as a result of the proposed lease sales and all OCS activity associated with previous lease sales. **Tables 3-2 and 3-3** of this Supplemental EIS and Table 3-6 of the 2012-2017 WPA/CPA Multisale EIS show the projected number of structure installations by water-depth range for the OCS Program.

Note that offshore and onshore impact-producing factors and scenarios associated with a WPA or an EPA proposed action (i.e., a typical lease sale that would result from a proposed action within the WPA or EPA), as well as OCS Program activity resulting from past and future lease sales in the WPA or EPA are disclosed in the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, WPA 238/246/248 Supplemental EIS, and EPA 225/226 EIS.

Bottom Area Disturbance

Chapter 3.1.1.3.2.1 of the 2012-2017 WPA/CPA Multisale EIS describes in detail bottom area disturbances. 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 are described in **Chapter 3.1.1.3** of this Supplemental EIS and in Chapters 3.1.1.3.1 and 3.1.1.3.2 of the 2012-2017 WPA/CPA Multisale EIS. 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.

Sediment Displacement

Chapter 3.1.1.3.2.2 of the 2012-2017 WPA/CPA Multisale EIS describes in detail 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.

Infrastructure Presence

Chapter 3.1.1.3.3 of the 2012-2017 WPA/CPA Multisale EIS describes in detail impact-producing factors due to infrastructure presence. The installation and maintenance of infrastructure may include, but is not limited to, the following:

- anchoring;
- offshore production systems;
- space-use requirements (deployment of survey equipment or bottom-founded production equipment);
- aesthetic quality (presence and visibility of equipment, vessels, and air traffic); and
- workovers and abandonments.

3.1.1.4. Operational Waste Discharged Offshore

Chapter 3.1.1.4 of the 2012-2017 WPA/CPA Multisale EIS describes in detail impacting factors due to operational wastes discharged offshore and Chapter 3.1.1.4 of the WPA 233/CPA 231 Supplemental EIS provides a summary as well as detailed updated information on more recent, stricter regulations regarding vessel discharges. Operational wastes discharged offshore include the following:

- drilling muds and cuttings;
- produced waters;
- well treatment, workover, and completion fluids;
- production solids and equipment;
- bilge, ballast, and fire water;
- cooling water;
- deck drainage;
- treated domestic and sanitary wastes;
- minor discharges;
- vessel operational discharges; and
- distillation and reverse osmosis brine.

BOEM 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. The amount discharged overboard for the years 2000-2012 is summarized by water depth in **Table 3-5**, with new data provided for the years 2010-2012. The total volume for all water depths during this 12-year period ranged from 489.0 to 648.2 MMbbl, with the largest contribution (69-88%) coming from operations on the shelf. The total volume of produced water generally decreased after 2004, reflecting an overall decrease in contributions from the shelf. The contribution of produced water from operations in deep water (>400 m [1,312 ft] water depth) and ultra-deepwater (>1,600 m [5,249 ft] water depth) production has been increasing. From 2000 to 2012, the contribution from these operations (deep and ultra-deepwater together) increased from 6 percent (37.8 MMbbl) to 27 percent (138.2 MMbbl) of the total produced-water volume (calculated from data in **Table 3-5**). The updated annual amounts and depth distributions of produced water discharged by depth are within the range of or similar to data presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Thus, this new information did not change the validity of the operational wastes discussion previously presented.

3.1.1.5. Air Emissions

In 1990, pursuant to Section 328 of the Clean Air Act Amendments and following consultation with the Commandant of the U.S. Coast Guard (USCG) and the Secretary of the Interior, the United States Environmental Protection Agency (USEPA) assumed air quality responsibility for the OCS waters in the GOM east of longitude 87.5° W., and this Agency retained National Ambient Air Quality Standards

(NAAQS) air quality jurisdiction for OCS operations west of the same longitude in the GOM. Air quality regulations are under a comprehensive review in 2014 to replace obsolete provisions and to ensure that updates in regulations are following improvements in scientific and technological information.

There are many air emissions sources related to OCS oil and gas exploration, development, and production in the GOM. During the exploration stage, most of the OCS non-platform emissions are from combustion from the equipment used on a drilling rig or from fuel usage of a support vessel. During the production stage, platform emission sources include boilers, diesel engines, combustion flares, fugitives, glycol dehydrators, natural gas engines, turbines, pneumatic pumps, pressure/level controllers, storage tanks, cold vents, and others. During the development stage, most of the OCS non-platform emissions are from fuel usage of support or survey vessels to lay pipelines, install facilities, or map geologic formations and seismic properties.

Pollutants released by OCS sources include the NAAQS pollutants CO, NO_x, PM, and SO_2. Pollutants also released by OCS sources (NO_x and VOC) are precursors to ozone, which is formed by photochemical reactions in the atmosphere and is another NAAQS pollutant. Lastly, OCS sources release greenhouse gas emissions, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

The *Year 2008 Gulfwide Emissions Inventory Study* (Wilson et al., 2010) indicates that, for calendar year 2008, OCS oil and gas production platforms and non-platform sources emit the majority of criteria pollutants and greenhouse gases in the GOM on the OCS, with the exception of PM and SO_2 (primarily emitted from commercial marine vessels) and N_2O (from biological sources). The OCS oil and gas production platform and non-platform sources account for 93 percent of the total CO emissions, 74 percent of NO_x emissions, 76 percent of VOC emissions, and 99 percent of the CH_4 emissions, and 84 percent of the CO_2 emissions. Natural gas engines on platforms represented the largest CO emission source, accounting for 60 percent of the total estimated CO emissions; and support vessels were the highest emitters of NO_x, accounting for 35 percent of the total estimated emissions. Oil and natural gas production platform vents and fugitive sources account for the highest percentage of VOC and CH_4 emissions. Support vessels (29% of total emissions), production platform natural gas turbines (15% of total emissions), and drilling rigs (12% of total emissions) emit the majority of the CO_2 emissions.

3.1.1.6. 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 long-lived or temporary. 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 depends both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and the sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause physical damage or death to an exposed animal and, in limited circumstances, can cause "take" of endangered and threatened species as defined in the Federal Endangered Species Act. Source levels well above hearing thresholds can damage hearing or induce behavioral changes (Richardson et al., 1995). Chapter 3.1.1.6 of the 2012-2017 WPA/CPA Multisale EIS describes in detail noise impact-producing factors associated with OCS oil and gas development.

3.1.1.7. Major Sources of Oil Inputs in the Gulf of Mexico

Petroleum hydrocarbons can enter the GOM from a wide variety of sources. The major sources of oil inputs in the GOM are natural seepage, permitted produced-water discharges, land-based discharges, and accidental spills. Numerical estimates of the contributions for these sources to the GOM coastal and offshore waters are shown in Tables 3-8 and 3-9 of the 2012-2017 WPA/CPA Multisale. Chapter 3.1.1.7 of the 2012-2017 WPA/CPA Multisale EIS describes in detail major sources of oil inputs in the Gulf of Mexico, including natural seepage, produced water, land-based discharges, and spills.

Chapter 3.1.1.7.4 of the 2012-2017 WPA/CPA Multisale EIS also describes in detail the following information related to oil spills: trends in reported spill volumes and numbers; projections of future spill events; OCS oil- and gas-related offshore spills; non-OCS oil- and gas-related offshore spills; OCS oil- and gas-related coastal spills; non-OCS oil- and gas-related coastal spills; and other sources of oil.

The most recent version of the USCG report, “Polluting Incidents In and Around U.S. Waters, A Spill/Release Compendium: 1969-2011” was published in December 2012 (U.S. Dept. of Homeland Security, CG, 2012a). This document summarizes spills reported to the USCG that occurred on navigable waters, including rivers, lakes and harbors, the territorial seas (0-3 mi [0-5 km] from the coastline), the contiguous zone (3-12 mi [5-19 km] from the coastline), and the marine environment. The data include over 174 different petroleum and nonpetroleum oils and over 50 source types, including barges, tanks, pipelines, and waterfront facilities. These data augment information included in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. According to the USCG report, crude oil and heavy fuel oil were spilled in the greatest volumes. Most spills and spill volume occurred in the GOM coastal waters and the western rivers system, which includes the Mississippi, Ohio, and Arkansas Rivers. For the 37-year period ending in 2009, the USCG’s databases for all U.S. waters contained investigations of more than 270,000 oil spills. The total spill amount during that period was 240.7 million gallons. The majority of spills through the years of this report involved discharges between 1 and 100 gallons. Thus, the oil discharged from the *Macondo* well (the source of the *Deepwater Horizon* oil spill in April 2010) represents the equivalent of 86 percent of all oil discharged in the preceding 37 years (U.S. Dept. of Homeland Security, CG, 2012a).

From 1991 through 2011, non-tank vessels accounted for 75.4 percent of the number of spills that occurred in U.S. waters (U.S. Dept. of Homeland Security, CG, 2012a). Historically, tank vessels (ships and barges) accounted for most of the volume spilled in U.S. waters. However, since passage of the Oil Pollution Act of 1990, the distribution of spill volumes has shifted away from tank vessel sources. For example, at the national level for the years 1999 through 2011, 29 percent of the volume of oil spilled came from tank vessels (e.g., ships/barges) compared with 41 percent from facilities and other non-vessels (the *Macondo* well was not included). Furthermore, in 2010, the largest oil spill in U.S. waters emanated from the exploratory *Macondo* oil well in the Gulf of Mexico. However, with the exception of rare but extreme incidents such as the *Deepwater Horizon* oil spill, the overall number and volume of spills in U.S. waters has been on a steady downward trend since 1973. In fact, 2010, the year of the largest recorded spill in U.S. waters, was followed by a record low annual volume of 210,270 gallons in 2011 (U.S. Dept. of Homeland Security, CG, 2012a).

Specifically, in 2010, the GOM region experienced 455 spills having a combined volume of 206,990,317 gallons, representing 15.1 percent of the total number of U.S. waterways spills and 99.7 percent of the total spillage volume in the U.S. waterways for that year. In 2011, 498 spills having a combined volume of 20,276 gallons occurred in the GOM, representing 16.2 percent of the total number of U.S. waterways spills and 9.6 percent of the total spillage volume in the U.S. waterways for that year (U.S. Dept. of Homeland Security, CG, 2012a). **Table 3-6** illustrates that the total number of spill incidents occurring per year in the GOM has generally declined during this period of time from a high of 1,728 reported incidents in 2001 to less than 523 yearly spill incidents reported since 2008.

3.1.1.8. Offshore Transport

Offshore transport includes both movements of oil and gas products as well as the transportation of equipment and personnel. Chapter 3.1.1.8 of the 2012-2017 WPA/CPA Multisale EIS describes in detail sources of offshore transport and proposed action scenarios, including pipelines (installation and maintenance; landfalls), barges, oil tankers and projections related to floating production, storage, and offloading systems (FPSO’s), service vessels, and helicopter trips. Updated information on total traffic (OCS- and non-OCS Program-related) on navigation channels for 2011 can be found in **Table 3-7**. This new information did not alter the projections or conclusions made in the 2012-2017 WPA/CPA Multisale EIS or WPA 233/CPA 231 Supplemental EIS.

3.1.1.9. Safety Issues

Safety issues related to OCS oil and gas development include the presence of hydrogen sulfide and sulfurous petroleum and shallow hazards. These safety issues are described in detail in Chapters 3.1.1.9.1 and 3.1.1.9.2 of the 2012-2017 WPA/CPA Multisale EIS. Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. These new and unusual technologies are described in Chapter 3.1.1.9.3 of the 2012-2017 WPA/CPA Multisale EIS.

3.1.1.10. Decommissioning and Removal Operations

During exploration, development, and production operations, the seafloor around activity sites within a proposed lease sale area becomes the repository of temporary and permanent equipment and structures. In compliance with Section 22 of BOEM's Oil and Gas Lease Form (BOEM-2005) and BSEE regulations (30 CFR §§ 250.1710 *et seq.—Permanently Plugging Wells* and 30 CFR §§ 250.1725 *et seq.—Removing Platforms and Other Facilities*), lessees are required to remove all seafloor obstructions from their leases within 1 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 (e.g., piles, jackets, caissons, templates, mooring devises, etc.) or the well (e.g., wellheads, casings, casing stubs). Decommissioning and removal operations, including the CPA proposed action and OCS Program scenarios, are described in detail in Chapter 3.1.1.10 of the 2012-2017 WPA/CPA Multisale EIS.

3.1.2. Coastal Impact- Producing Factors and Scenario

3.1.2.1. Coastal Infrastructure

Chapter 3.1.2 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS discuss coastal impact-producing factors and provide scenario projections for onshore coastal infrastructure that may potentially result from a single CPA proposed action in the Five-Year Program. These coastal impact-producing factors could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico. Chapter 3.1.2.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS provide summaries as well as detailed updated information on OCS oil- and gas-related coastal infrastructure types, which include the following:

- service bases;
- helicopter hubs;
- platform fabrication yards;
- shipbuilding and shipyards;
- pipecoating facilities and yards;
- refineries;
- gas processing plants;
- liquefied natural gas (LNG) facilities;
- pipeline shore facilities, barge terminals, and tanker port areas;
- coastal pipelines;
- coastal barging; and
- navigation channels (see updated information on navigation channels in Table 3-7).

This OCS oil- and gas-related infrastructure has been developed over many decades, and it is an extensive and mature system that provides support for offshore activities. The expansive presence of this coastal infrastructure is the result of long-term industry trends and is not subject to rapid fluctuations. BOEM projects no new coastal infrastructure with the exception of 0-1 new pipeline landfall and 0-1 new gas processing facility as a result of an individual proposed action. Existing solid-waste disposal infrastructure is projected to be adequate to support both existing and projected offshore oil and gas drilling and production needs. Detailed descriptions of the baseline affected environment for land use and coastal infrastructure in the CPA are provided in **Chapter 4.2.1.23.1.1** of this Supplemental EIS, Chapter 4.2.1.23.1.1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.23.1 of the WPA 233/CPA 231 Supplemental EIS.

The U.S. Energy Information Administration updates national energy projections annually, including refinery capacity. A crude oil refinery is a group of industrial facilities that turns crude oil and other inputs into finished petroleum products. A refinery's capacity refers to the maximum amount of crude oil designed to flow into the distillation unit of a refinery, also known as the crude unit. Most of the GOM region's refineries are located in Texas and Louisiana (Table 3-13 of the 2012-2017 WPA/CPA Multisale EIS). Texas has 26 operable refineries, with an operating capacity of over 4.6 MMbbl/day, which is close to 28 percent of the total U.S. capacity. Louisiana follows closely behind Texas, with 18 operable refineries, with an operational capacity of over 3.0 MMbbl/day, which is 18 percent of the total U.S. capacity (USDOE, Energy Information Administration, 2013c).

For all domestic refineries, distillation capacity is expected to stay at a steady rate of 17.5 MMbbl/day over the 40-year period (USDOE, Energy Information Administration 2013c). For many years financial, environmental, and legal considerations have prevented the construction of new refineries in the U.S., thereby forcing companies to expand and retrofit existing facilities. Domestic refinery expansions are largely being driven by unconventional sources of oil, primarily Canadian oil sands (Sreekumar, 2013). The Canadian heavy crude is cheaper to purchase but costlier to refine, and many refineries planning to take advantage of the newest discoveries are expanding their facilities to handle the higher volumes of impurities associated with heavier crude oils (Rigzone, 2013).

In 2008, projections indicated that the U.S. would need to ramp up its natural gas imports, and industry began constructing LNG containers along Gulf ports to accommodate the influx in imports (Helman, 2013). In 2013, onshore unconventional natural gas production increased to the point that existing Gulf Coast LNG facilities are seeking to export natural gas to foreign countries. In 2011, Cheniere's Sabine Pass, Louisiana, facility received approval from the Department of Energy to export to any country in the world (Helman, 2013; U.S. Dept. of Energy, Federal Energy Regulatory Commission, 2013). Twelve additional project sponsors have applied to DOE for authorization to export domestically produced LNG to free trade agreement and non-free trade agreement countries (Dismukes, 2013a and b; U.S. Dept. of Energy, Federal Energy Regulatory Commission, 2013).

3.1.2.2. Discharges and Wastes

Chapter 3.1.2.2 of the 2012-2017 WPA/CPA Multisale EIS describes in detail coastal discharges and wastes and Chapter 3.1.2.2 of the WPA 233/CPA 231 Supplemental EIS provides a summary and updates to these coastal discharges and wastes, which include the following:

- disposal and storage facilities for offshore operational wastes;
- onshore facility discharges;
- coastal service-vessel discharges;
- offshore wastes disposed onshore; and
- beach trash and debris.

The USEPA currently regulates vessel discharges with the Vessel General Permit (VGP), which is a Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit that authorizes, on a nationwide basis, discharges incidental to the normal operation of nonmilitary and nonrecreational vessels greater than or equal to 79 ft (24 m) in length. On March 28, 2013, USEPA reissued the 2008 VGP for another 5 years; the reissued permit, the 2013 VGP, now contains numeric ballast water discharge limits for most vessels. The VGP also contains more stringent effluent limits for oil-to-sea interfaces and exhaust gas scrubber washwater. There is also a Small Vessel General Permit (sVGP), which if finalized, would authorize discharges incidental to the normal operation of nonmilitary and nonrecreational vessels less than 79 ft (24 m) in length and commercial fishing vessels (USEPA, 2013a).

BOEM's policy regarding marine debris prevention is outlined in NTL 2012-G01, "Marine Trash and Debris Awareness and Elimination." This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harms of discharging marine debris. The NTL also states that OCS workers should complete annual marine debris prevention training and instructs operators to develop a certification process for the completion of this training by their workers. These various laws, regulations, and NTL's will likely minimize the discharge of marine debris from OCS operations.

3.2. IMPACT-PRODUCING FACTORS AND SCENARIO—ACCIDENTAL EVENTS

3.2.1. Oil Spills

Oil spills are unplanned accidental events, and historical data provide the most relevant data for use in predicting future oil-spill frequency and volume in the GOM on a programmatic level. The following sections discuss spill prevention and spill response, and analyze the risk of spills that could occur as a result of activities associated with a CPA proposed action. Public input through scoping meetings and Federal and State agencies' input through consultation and coordination indicate that oil spills are perceived to be a major issue, especially in the wake of the *Deepwater Horizon* oil spill. The following sections analyze the risk of spills that could occur as a result of a typical CPA proposed action, as well as information on the number and sizes of spills from non-OCS sources. Refer to **Appendix B** for the "Catastrophic Spill Event Analysis."

3.2.1.1. Spill Prevention

In the 1980's, this Agency 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**). With the exception of rare incidents such as the *Deepwater Horizon* oil spill, an overall reduction in spill volume had occurred during the previous 40 years, while oil production had generally increased. A characterization of spill rates, average and median volumes from 1995 to 2009 compared with characterization of spill rates, average and median volumes from 1996 to 2010 (latest analysis available), which includes the *Deepwater Horizon* oil spill, is provided in *Update of Occurrence Rates for Offshore Oil Spills* (Anderson et al., 2012). BOEM attributes this overall reduction in spill volume to its operational requirements, ongoing efforts by the oil and gas industry to enhance safety and pollution prevention, and the evolution and improvement of offshore technology.

3.2.1.2. Past OCS Spills

BOEM's spill-event database includes records of past spills from activities that are regulated by BOEM. 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. Anderson et al. (2012) was utilized in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS to characterize spill rates and to provide analysis for average and median volumes. The Anderson et al. (2012) analysis examined spill data for the period 1964 to 2010, including the *Deepwater Horizon* oil spill.

A search of BSEE's oil-spill database (USDOI, BSEE, 2013a) was performed to assess new spill information during the 2011-2012 period and to provide an update to the Anderson et al. (2012) analysis. During the period 2011 to 2012, there were 35 spills from OCS oil and gas activities of <1,000 bbl in size. The breakdown of the 35 spills <1,000 bbl that occurred in 2011 and 2012 from OCS oil and gas activities into size classes is as follows: 19 spills of 1-4 bbl; 5 spills of 5-9 bbl; 9 spills of 10-49 bbl; 1 spill of 50-99 bbl; 1 spill of 100-999 bbl; and 0 spills of ≥1,000 bbl. The combined total of oil spilled in these 35 events was 815 bbl. The BSEE database (USDOI, BSEE, 2013a) indicated that there were two spills (one in 2011 and one in 2012) that were between 50 and 500 bbl in size, both of which occurred in the CPA. The spill in 2011 equaled 67 bbl and was the result of equipment failure from a platform leak located in Garden Banks Block 72. The spill in 2012 was estimated at 480 bbl and resulted from an explosion on a platform located in West Delta Block 32. However, the 2012 spill is still under investigation and observations collected during the spill suggest that the spill volume was actually much smaller. In summary, two spills >50 bbl occurred in the CPA during the period 2011 to 2012. This is an outcome that is well within the range of spills estimated to occur in Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS, which serves as an estimate of the number and size of spills likely to occur as a result of a CPA proposed action over a 40-year time period. Thus, the additional information provided by the review of BSEE's oil-spill database (USDOI, BSEE 2013a) did not change the validity of the scenario previously presented.

The majority of the 2011-2012 spills are attributed to OCS platforms/rigs, followed by vessels, and lastly by OCS pipelines. These data were compared with the estimated number and sizes of spills presented in Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS (derived in part from Anderson et al., 2012), and it was found that the new spill data were well within the spill numbers estimated in the previous document. The new data also concurred with the previous finding that the most likely source of a spill would be from platforms, rigs, or vessels. Thus, a review of recent information does not change the risk analyses for spills <1,000 bbl previously provided in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. As estimated in Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS, no spills have occurred in the ≥1,000-bbl size class during 2011 and 2012.

3.2.1.3. Characteristics of OCS Oil

The physical and chemical properties of oil greatly affect its transport and its ultimate fate in the environment and determine the following: how oil will behave on the water surface (surface spills) or in the water column and sediments (subsea spills); the persistence of the slick on the water; the type and speed of weathering processes; 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 natural mixture of hundreds of different compounds, with liquid hydrocarbons accounting 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 American Petroleum Institute gravity (API gravity) is a measure of the relative density of oil compared with water and is expressed in degrees (°). Oils with an API gravity <10 are heavier and typically sink, whereas oils with an API gravity >10 are lighter and typically float. Following an oil spill, the composition of the released oil can change substantially due to weathering processes such as evaporation, emulsification, dissolution, and oxidation. More details on the properties and persistence of different types of oils are provided in Table 3-7 of the WPA 233/CPA 231 Supplemental EIS.

Extensive laboratory testing has been performed on various oils from the GOM to determine their physical and chemical characteristics. For example, numerous oils collected from the GOM (U.S. waters) are included in Environment Canada's (2013) oil properties database. The database provides details of an oils chemical composition including hydrocarbon groups (i.e., saturates, aromatics, resins, asphaltenes), VOC's (such as benzene, toluene, ethylbenzene, and xylene), sulfur content, biomarkers, and metals. The database also includes API gravities, of which GOM oils are in the range of 15° to 60°. Since the Deepwater Horizon oil spill, new data have been analyzed from the approximately 450 deepwater exploration plans (EP's) and DOCD's that were submitted to BOEM/BSEE. Statistics on these API gravities result in a similar range (16° to 58°) as previously reported, with a mean value of 36°. These new data corroborate the information previously presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

3.2.1.4. Overview of Spill Risk Analysis

There are many factors that BOEM evaluates to determine the risk of impact occurring from an oil spill, including 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. Sensitivity of the environmental resources and potential effects are addressed in the analyses for the specific resources of concern (**Chapter 4.1**). BOEM uses data on past OCS production and spills, along with estimates of future production, to evaluate the risk of future spills. Additionally, BOEM uses a numerical model to calculate the likely trajectory of spills (i.e., transport pathways) and analyzes historical data of occurrence rates for oil spills (refer to Anderson et al., 2012) to make projections of future oil-spill frequency and size. A more detailed description of the spill risk analysis and the trajectory model, called OSRA (oil-spill risk analysis) model, were provided in Chapter 3 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, as well as in the Ji et al. (2012) OSRA report. **Appendix C** of this Supplemental EIS also contains the OSRA model's catastrophic spill event results to estimate the risks associated with a possible future low-probability catastrophic or high-volume, long-duration oil spill.

The OSRA model results and estimated spill size/frequency tables as presented and discussed in the 2012-2017 WPA/CPA Multisale EIS remain applicable because the basic assumptions inherent in the model and calculations are still valid. The latest analysis available for the characterization of spill rates and for average and median volumes (Anderson et al., 2012) inputted into the model is still valid because the more recent small OCS spills (2011-2012) were within spill scenario estimates developed using the past data. In addition, the physical forcing (e.g., ocean currents and wind fields) and environmental resources input (e.g., locations and seasonality of various biological resources) to the OSRA model are still representative of our current state of knowledge regarding both ocean modeling and potential environmental resources at risk. Numerous efforts are underway since the *Deepwater Horizon* oil spill to further improve trajectory modeling in the Gulf of Mexico, including several BOEM environmental studies (e.g., refer to Section 4.2 in Ji et al., 2013). However, the results of these new research activities are not yet available or fully tested for incorporation into BOEM's oil-spill risk analysis. Thus, new information did not change the results of previous spill risk analyses provided in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The following discussions provide separate risk information for offshore and coastal spills that may result from a CPA proposed action. This analysis is divided into discussions of offshore spills ≥1,000 bbl, offshore spills <1,000 bbl, and coastal spills of any spill volume. Only spills ≥1,000 bbl are addressed using OSRA because smaller spills typically do not persist long enough to be simulated by trajectory modeling.

3.2.1.5. Risk Analysis for Offshore Spills ≥1,000 bbl

Chapter 3.2.1.5 of the 2012-2017 WPA/CPA Multisale EIS addressed the risk of spills ≥1,000 bbl that could occur from accidents associated with activities resulting from a CPA proposed action. The risk analyses included the following:

- estimated number of offshore spills ≥1,000 bbl and probability of occurrence;
- most likely source of offshore spills ≥1,000 bbl;
- most likely size of an offshore spill ≥1,000 bbl;
- fate of offshore spills ≥1,000 bbl;
- transport of spills ≥1,000 bbl by winds and currents;
- length of coastline affected by offshore spills ≥1,000 bbl; and
- likelihood of an offshore spill ≥1,000 bbl occurring and contacting modeled locations of environmental resources.

Specifically, for a CPA proposed action, the mean number of spills was estimated at <1-1 spill (mean equal to 0.5-1.0) total from both OCS platforms and OCS pipelines, with an overall 41-62 percent chance of one or more spills ≥1,000 bbl occurring in the CPA. Based on historical data, the most likely source of an offshore spill was determined to be a potential pipeline break at the seafloor.

Because no spills ≥1,000 bbl in size have occurred during 2011-2012, use of Anderson et al. (2012) remains applicable and up to date for characterizing spill rates and average and median spill volumes in this Supplemental EIS. In terms of weathering, fate, and transport of oil spills in the Gulf of Mexico, a variety of ongoing studies are providing more insights in the aftermath of the *Deepwater Horizon* oil spill. For example, recent studies have provided further evidence that the diverse microbial communities in both the water column (e.g., Mason et al., 2012) and sediments (Kimes et al., 2013) of the GOM can play an active role in metabolizing and bioremediating crude oil from offshore spills. Further research is also being conducted regarding what impact chemical dispersant application may have on this biodegradation process. Other research on oil fates suggests that marine snow formation in the aftermath of a large oil-spill event (such as the *Deepwater Horizon* oil spill) may play a key role in the fate of surface oil (e.g., Passow et al., 2012). However, many of the important recent findings related to the quantitative modeling of fate and transport of large oil spills in the Gulf of Mexico are part of the ongoing Natural Resource Damage Assessment (NRDA) process and have not yet been publicly released. Thus, a review of recent information does not change the quantitative risk analyses for spills ≥1,000 bbl previously provided the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

3.2.1.6. Risk Analysis for Offshore Spills <1,000 bbl

Chapter 3.2.1.6 of the 2012-2017 WPA/CPA Multisale EIS addressed the the risk of spills <1,000 bbl resulting from a CPA proposed action. Analysis of historical data shows that most offshore OCS oil spills fall within this category, with the majority of spills falling within the significantly smaller range of ≤1 bbl (Anderson et al., 2012). Although spills of ≤1 bbl amount to 96 percent of all OCS oil- and gas-related spill occurrences, they have contributed very little to the total volume of oil spilled. The risk analyses addressed in Chapter 3.2.1.6 of the 2012-2017 WPA/CPA Multisale EIS included the following:

- estimated number of offshore spills <1,000 bbl and total volume of oil spilled;
- most likely source and type of offshore spills <1,000 bbl;
- most likely size of offshore spills <1,000 bbl;
- persistence, spreading, and weathering of offshore oil spills <1,000 bbl;
- transport of spills <1,000 bbl by winds and currents; and
- likelihood of an offshore spill <1,000 bbl occurring and contacting modeled locations of environmental resources.

A search of BSEE's oil-spill database (USDOI, BSEE, 2013a) was performed to assess new spill information during 2011-2012, a period that was not analyzed in Anderson et al. (2012). During 2011-2012, there were 35 spills from OCS oil and gas activities of <1,000 bbl in size, totaling 815 bbl overall. The breakdown of these spills into size classes is provided in **Chapter 3.2.1.2**. As noted above, the 2011-2012 spill data were compared with the estimated number and sizes of spills presented in Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS and were found to be well within the spill numbers estimated in the previous document. The new data also supported previous findings that the most likely source of a spill of <1,000 bbl would be from platforms, rigs, or vessels. Thus, a review of recent information does not change the risk analyses for spills <1,000 bbl previously provided in Chapter 3.2.1.6 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

3.2.1.7. 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. BOEM projects that almost all (>99%) oil produced as a result of a CPA 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 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. Chapter 3.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS describes in detail the estimated number and most likely sizes of coastal spills and the likelihood of coastal spill contact.

The USCG released a more recent version of the report titled *Polluting Incidents In and Around U.S. Waters Spill/Release Compendium, 1969-2011*, which includes data for the years 2010 and 2011 (U.S. Dept. of Homeland Security, CG, 2012a). The updated version of the USCG report included an additional 953 spills for 2010 and 2011 in inland, coastal, and OCS waters across the GOM; these spills were not reported in Chapter 3.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS (U.S. Dept. of Homeland Security, CG, 2012a).

The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of hydrocarbon use by commercial and recreational activities remains the same. Estimates of future coastal spills are based on historical spills reported to USCG; consequently, in the GOM region, Louisiana and Texas are the states most likely to have a spill ≥1,000 bbl occur in coastal waters. A spill that occurs in Federal waters could also be transported to State waters via wind/currents. For offshore spills ≤1000 bbl, only those >50 bbl would be expected to have a chance of persisting long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl in size are estimated to occur as a result of a proposed action within the proposed CPA lease sale area 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.

3.2.1.8. Risk Analysis by Resource

BOEM previously analyzed the risk to resources from oil spills and oil slicks that could occur as a result of a CPA proposed action in the 2012-2017 WPA/CPA Multisale EIS. The risk results were based on BOEM's estimates of likely spill locations, sources, sizes, frequency of occurrence, physical fates of different types of oil slicks, and probable transport that were described in more detail in specific spill scenarios. For offshore spills ≥1,000 bbl, combined probabilities were calculated using the OSRA model, which includes both the likelihood of a spill from a proposed action occurring and the likelihood of the oil slick reaching areas where known environmental resources exist. 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 was provided under each resource category in **Chapter 4.1.1** of this Supplemental EIS and was provided in Chapter 4.1.1 of the WPA 233/CPA 231 Supplemental EIS and in Chapter 3.2.1.8 and Figures 3-8 through 3-28 of the 2012-2017 WPA/CPA Multisale EIS. Coastal spills were estimated from historic counts; the estimate was not a rate tied to an anticipated production volume or a probability.

3.2.1.9. Spill Response

Chapter 3.2.1.9 of the 2012-2017 WPA/CPA Multisale EIS describes in detail offshore spill response. Issues discussed related to spill response include offshore response, containment, and cleanup technology; and onshore response and cleanup.

As a result of the Oil Pollution Act of 1990 and the reorganization of the Bureau of Ocean Energy Management, Regulation and Enforcement into BOEM and BSEE, BSEE was tasked with a number of oil-spill response duties and planning requirements. The following requirements are implemented according to BSEE's regulations at 30 CFR parts 250 and 254:

- requires immediate notification for spills >1 bbl—all spills require notification to USCG, and BSEE 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;
- oversee spill source control and abatement operations by industry;
- sets requirements and reviews and approves oil-spill response plans (OSRP's) 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.

As indicated above, BSEE is now responsible for review and approval of OSRP's. BOEM's regulations require that an operator must have an approved OSRP prior to BOEM's approval of an operator-submitted EP, DOCD, or production plan. Hence, BOEM relies heavily upon BSEE's expertise to ensure that the OSRP complies with all pertinent laws and regulations and demonstrates the ability of an operator to respond to a worst-case discharge.

This Agency also issued NTL's and guidance documents that clarified additional oil-spill requirements after the *Deepwater Horizon* explosion, oil spill, and response occurred. The spill-response-related NTL's and guidance documents issued by BOEM and BSEE are described in detail in Chapter 3.2.1.9 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The NTL 2012-BSEE-N06, "Guidance to Owners and Offshore Facilities Seaward of the Coast Line Concerning Regional Oil Spill Response Plans," was not discussed in the 2012-2017 WPA/CPA Multisale EIS since it was not effective until August 10, 2012. That NTL provides clarification, guidance, and information concerning the preparation and submittal of a regional OSRP for owners and operators of oil handling, storage, or transportation facilities, including pipelines located seaward of the coastline. The NTL also informs lessees, designated operators, or pipeline right-of-way holders, as appropriate, that they are responsible for preparing and submitting the OSRP. The BSEE's Oil Spill Response Division will review all OSRP's and approve those OSRP's that are in compliance with 30 CFR part 254. Some of the clarifications and encouraged practices in the NTL are based on lessons learned from the *Deepwater Horizon* explosion, oil spill, and response. Per the NTL, adherence to the *encouraged* practices will facilitate BSEE's review of the OSRP's, but adherence is not required to obtain approval. During BSEE's review of regional OSRP's, the Oil Spill Response Division will analyze the content of OSRP's to ensure that the lessees demonstrate the ability to respond quickly and effectively whenever oil is discharged from a covered facility, as required by 30 CFR part 254. The NTL encourages lessees to specifically describe the planned response strategy for each worst-case discharge scenario included in the regional OSRP. The NTL indicates that the following factors should be considered when developing a response strategy:

- location of the potential worst-case discharge;
- proximity to sensitive resources;
- nature of the event;
- estimated discharge volume;
- oil characteristics;
- appropriate source control;
- containment methods;
- weathering (including natural dispersion); and
- other resources at risk.

There have been some changes to the spill-response equipment staging locations previously reported in the 2012-2017 WPA/CPA Multisale EIS. Due to these changes, it is expected that the oil-spill response equipment needed to respond to an offshore spill in the proposed CPA lease sale area could be called out from one or more of the following oil-spill equipment base locations: New Iberia, Belle Chase, Sulphur, Houma, Port Fourchon, Fort Jackson, Venice, Grand Isle, or Lake Charles, Louisiana; La Porte, Port Arthur, Aransas Pass, Ingleside, Galveston, or Houston, Texas; Pascagoula, Mississippi; Mobile, Alabama; or Pensacola, Panama City, Tampa, or Miami, Florida (USDOI, BSEE, 2013b).

In addition, the USCG has worked diligently to improve coastal oil-spill response since the *Deepwater Horizon* oil spill by replacing the One Gulf Plan with separate Area Contingency Plans (ACP's) for each coastal USCG sector. The ACP's cover subregional geographic areas and represent the third tier of the National Response Planning System mandated by the Oil Pollution Act of 1990. The

ACP's are a focal point of response planning. The Gulf of Mexico OCS Region's ACP's also include separate Geographic Response Plans, which are developed jointly with local, State, and other Federal entities to better focus spill response tactics and priorities. These Geographic Response Plans contain the resources initially identified for protection during a spill, response priorities, procedures, and appropriate spill-response countermeasures.

During the *Deepwater Horizon* shoreline response, oiling conditions generally included surface and buried oil layers, surface and buried oil/sand balls, stained sand, and sunken oil in the adjacent subtidal waters. Since waste minimization was a core principle considered when cleaning sand beaches, efforts were made to remove as little sediment as practical from the shore zone during cleaning operations. Treatment methods for sand beaches comprised manual and mechanical removal, an on-site treatment plant, and sediment relocation. Mechanical removal involved a range of commercial self-propelled or towed machines designed primarily to sieve debris and litter on recreational beaches. Field trials were conducted to evaluate which specific mechanisms were more appropriate for the different oiling conditions. The beach cleaners were used as scrapers on the more heavily oiled beaches in Louisiana, whereas the sieving function was more appropriate to recover oil particles on the beaches of Mississippi, Alabama, and Florida. Oiled wetlands included *Spartina* salt marshes and *Phragmites* ("roseau cane") brackish-freshwater wetlands in the Mississippi Delta. Because previous spills in this region provided an understanding of the recovery potential for the oiled wetlands, natural recovery was the preferred strategy in most cases based on the generally light oiling conditions. Natural attenuation was relatively rapid if an area was only lightly oiled, as the *Macondo* well oil type had an API gravity of 35. A guiding principle for wetland treatment was to minimize physical intrusion and work from floating platforms, skiffs, or shallow-draft barges, whenever possible. Floating mechanical flushing machines, using concrete pump arms, were used on a limited scale to reach into oiled fringe wetlands to wash and recover mobile oil. Oiled rip rap, breakwaters, and groins and jetties were treated through manual removal of bulk oil and were washed using a range of temperatures and pressure depending on the character of the oil (Owens et al., 2011).

3.2.2. Losses of Well Control

All losses of well control must be reported to BSEE. The BSEE clarified its procedure for loss of well control incident reporting in NTL 2010-N05, "Increased Safety Measures for Energy Development on the OCS," effective June 8, 2010. The BSEE has also promulgated the Drilling Safety Rule (*Federal Register*, 2012a), effective October 22, 2012, which implements certain additional safety measures recommended in NTL 2010-N05 by incorporating the recommendations contained in the DOI report *Increased Safety Measures for Energy Development on the Outer Continental Shelf* (Safety Measures Report), dated May 27, 2010, and the *Deepwater Horizon* Joint Investigation Team report. The BSEE amended the drilling, well-completion, well-workover, and decommissioning regulations related to well control, including subsea and surface blowout preventers, well casing and cementing, secondary intervention, unplanned disconnects, recordkeeping, and well plugging. The Drilling Safety Rule also enhanced the description and classification of well-control barriers, defined testing requirements for cement, clarified requirements for the installation of dual mechanical barriers, and extended requirements for blowout preventers (BOP's) and well-control fluids to well-completions, workovers, and decommissioning operations. Operators are required to document any loss of well-control event, even if temporary, and the cause of the event, and they are required to furnish that information by mail or email to the addressee indicated in the NTL. The operator does not have to provide information on kicks that were controlled, but the operator should include the release of fluids through a flow diverter (a conduit used to direct fluid flowing from a well away from the drilling rig).

The current definition for loss of well control is as follows:

- uncontrolled flow of formation or other fluids (the flow may be to an exposed formation [an underground blowout] or at the surface [a surface blowout]);
- uncontrolled flow through a diverter; and/or
- uncontrolled flow resulting from a failure of surface equipment or procedures.

A loss of well control can occur during any phase of development, i.e., exploratory drilling, development drilling, well completion, production, or workover operations. A loss of well control can occur when improperly balanced well pressure results in sudden, uncontrolled releases of fluids from a wellhead or wellbore (PCCI Marine and Environmental Engineering, 1999; Neal Adams Firefighters, Inc., 1991). From 2006 to 2010, of the 27 loss of well-control events reported in the GOM, 7 (26%) resulted in loss of fluids at the surface or underground (USDOI, BSEE, 2012). In addition to spills, the loss of well control can resuspend and disperse bottom sediments. Historically, since 1971, most OCS blowouts have resulted in the release of gas, while blowouts resulting in the release of oil have been rare.

A BOP is a device with a complex of choke lines and hydraulic rams mounted atop a wellhead designed to close the wellbore with a sharp horizontal motion that may cut through or pinch shut casing and sever tool strings. The BOP's were invented in the early 1920's and have been instrumental in ending dangerous, costly, and environmentally damaging oil blowouts on land and in water. The BOP's have been required for OCS oil and gas operations from the time offshore drilling began in the late 1940's.

The BOP's are actuated as a last resort upon imminent threat to the integrity of the well or the surface rig. For a cased well, which is the typical well configuration, the hydraulic ram of a BOP may be closed if oil or gas from an underground zone enters the wellbore to destabilize the well. By closing a BOP, usually by redundant surface-operated and hydraulic actuators, the drilling crew can prevent explosive pressure release and allow control of the well to be regained by balancing the pressure exerted by a column of drilling mud with formation fluids or gases from below. Chapter 3.2.1.9.2 of the 2012-2017 WPA/CPA Multisale EIS provides information on subsea well containment that could be utilized if a loss of well control occurred and resulted in a loss of fluids.

3.2.3. Pipeline Failures

The potential mechanisms for damage to OCS pipeline infrastructure include mass sediment movements and mudslides that can exhume or push the pipelines into another location, impacts from anchor drops or boat collisions, and accidental excavation or breaching because the exact whereabouts of a pipeline is uncertain. Pipeline failures could also be by rig/platform and pipeline activities supporting a CPA proposed action. Chapter 3.2.3 of the 2012-2017 WPA/CPA Multisale EIS describes previous incidents of OCS oil- and gas-related pipeline failures.

Any one of the mechanisms listed above could cause an OCS oil- and gas-related oil spill ≥1,000 bbl. Any resulting spill size would be limited by the size of the pipeline and the ability of an operator to quickly shut off flow from the source. The median spill size estimated from a pipeline failure is 2,200 bbl (Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS). For a CPA proposed action, up to one spill of this size is estimated to occur during 40-year analysis period.

3.2.4. Vessel Collisions

The BSEE revised operator incident reporting requirements in a final rule effective July 17, 2006 (*Federal Register*, 2006). The new incident reporting rule more clearly defines what incidents must be reported, broadens the scope to include incidents that have the potential to be serious, and requires the reporting of standard information for both oral and written reports. As part of the incident reporting rule, BSEE's regulations at 30 CFR § 250.188(a)(6) require an operator to report all collisions that result in property or equipment damage greater than $25,000. "Collision" is defined as the act of a moving vessel (including an aircraft) striking another vessel or striking a stationary vessel or object (e.g., a boat striking a drilling rig or platform). Chapter 3.2.4 of the 2012-2017 WPA/CPA Multisale EIS provides data related to vessel collisions and discusses methods of prevention and avoidance of vessel collisions. No new data have emerged that would cause BSEE to reevaluate its analysis for this Supplemental EIS.

3.2.5. Chemical and Drilling-Fluid Spills

Chapter 3.2.5 of the 2012-2017 WPA/CPA Multisale EIS describes OCS oil- and gas-related chemical and synthetic-based fluid spills. Below is a brief summary of that information.

Chemicals are stored and used to condition drill muds during production and in well completions, stimulation, and workover procedures. The most common chemicals spilled are methanol, ethylene glycol, and zinc bromide. Methanol and ethylene glycol may be used as a treatment to prevent the formation of gas hydrates while zinc bromide may be used in completion fluids. The chemicals that are used the most are also the chemicals that are spilled in the greatest volume. Completion fluids are used in the largest quantity and constitute the largest volume of accidental releases. Completion fluids consist of brines made from seawater mixed with calcium chloride, calcium bromide, and/or zinc bromide. 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. Most other chemicals are either nontoxic or used in small quantities. There are some differences in the operational needs for chemicals in deepwater versus shallow-water operations. Higher volumes of treatment chemicals (e.g., defoamers and hydrate inhibitors) are used in deepwater environments due to the conditions encountered there (Boehm et al., 2001).

Synthetic-based fluids (SBF's) or synthetic-based muds (SBM's) have been used since the mid 1990's. In deepwater drilling, SBF's are preferred over water-based muds because of the SBF's superior performance properties. The synthetic oils used in SBF's are relatively nontoxic to the marine environment and have the potential to biodegrade. However, it should be noted that SBF's are not permitted to be discharged into the marine environment; only cuttings wetted with SBF may be discharged after the majority of synthetic fluid has been removed. For further discussion on this topic, refer to Chapter 3.1.1.4.1 of the 2012-2017 WPA/CPA Multisale EIS. Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when SBF's are in use.

The BSEE tracks spill incidents of ≥1 bbl in size of chemical and synthetic-based fluids resulting from OCS oil and gas activities, and has historically produced counts and summaries for spills ≥50 bbl.. **Table 3-8** provides information related to the number and volume of chemical and synthetic-based fluid spills in the GOM based on BSEE's counts and summaries. These data have been updated since the WPA 233/CPA 231 Supplemental EIS, which covered spills during the period of 2002-2009. A summary of 2013 data is not yet available. However, BOEM has conducted a search of the National Response Center database for standard reports using the search criteria "drilling mud" under the database's "material" field. This search revealed one spill of ≥1,000 bbl, which was a spill of 1,531 bbl in April 2013 due to an unplanned riser disconnect (U.S. Dept. of Homeland Security, CG, 2013). Despite this spill, the updated chemical and SBF spills remain within the range of data presented in the 2012-2017 WPA/CPA Multisale EIS (Table 3-27) and WPA 233/CPA 231 Supplemental EIS. Thus, this new information did not change the validity of the chemical and SBF spills previously presented.

3.3. CUMULATIVE ACTIVITIES SCENARIO

3.3.1. 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. Projected reserve/resource production for the OCS Program (**Table 3-1**; WPA, CPA, and EPA) is 18.34-25.64 BBO and 75.886-111.627 Tcf of gas. **Table 3-3** of this Supplemental EIS presents projections of the major activities and impact-producing factors related to future Gulf of Mexico OCS Program activities.

The level of OCS activity is connected to oil prices, resource potential, cost of development, and rig availability rather than just, or even primarily to, the amount of acreage leased. The impacts of activities associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the cumulative impacts analysis sections of **Chapter 4.1** of this Supplemental EIS and Chapters 4.1.1 and 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 233 Supplemental EIS.

Note that offshore and onshore impact-producing factors and scenarios associated with a WPA or an EPA proposed action (i.e., a typical lease sale that would result from a proposed action within the WPA or EPA) as well as OCS Program activity resulting from past and future lease sales in the WPA or EPA, are disclosed in the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, WPA 238/246/248 Supplemental EIS, and EPA 225/226 EIS.

3.3.2. State Oil and Gas Activity

All five Gulf Coast States have had some historical oil and gas exploration activity and, with the exception of Florida and Mississippi, currently produce oil and gas in State waters. The coastal infrastructure that supports the OCS Program also supports State oil and gas activities.

State oil and gas infrastructure consists of the wells that extract hydrocarbon resources, facilities that produce and treat the raw product, pipelines that transport the product to refineries and gas facilities for further processing, and additional pipelines that transport finished product to points of storage and final consumption. The type and size of infrastructure that supports production depends upon the size, type, and location of the producing field, the time of development, and the life cycle stage of operations. Chapter 3.3.2 of the 2012-2017 WPA/CPA Multisale EIS provides a reference for relevant historical information on State leasing programs. The most recent lease sale information for Texas and Louisiana has been updated below.

Texas

The most recent oil and gas lease sale occurred on January 7, 2013. Ninety-two parcels containing more than 27,432 ac of State lands were offered for oil and gas leasing in the offshore area by Texas State University Lands (State of Texas, General Lands Office, 2014). BOEM expects that Texas will conduct regular oil and gas lease sales during the 40-year cumulative activities scenario for OCS activity, although the lease sale's regularity could differ from current practices.

Louisiana

The most recent oil and gas lease sale occurred on January 9, 2014. Twenty-four leases containing more than 35,633 ac were offered for oil and gas leasing by the Office of Mineral Resources on the behalf of the State Mineral Board for Louisiana. The January 9, 2014, State lease sale awarded two leases for eight offered offshore areas, with a total acreage of 500 ac. During the 2012-2013 Fiscal Year, 45 offshore leases containing more than 83,187 ac were offered; of these, only 13 leases were awarded. BOEM expects that Louisiana will conduct regular oil and gas lease sales during the 40-year cumulative activities scenario for OCS activity, although the lease sale's regularity could differ from current practices (State of Louisiana, Dept. of Natural Resources, 2014).

Mississippi

BOEM expects Mississippi to institute a lease sale program in the near future and to begin leasing in State waters during the 40-year cumulative activities scenario for OCS activity analyzed in this Supplemental EIS.

Alabama

Alabama has no established schedule of lease sales. The limited number of blocks in State waters has resulted in the State not holding regularly scheduled lease sales. The last lease sale was held in 1997. BOEM does not expect Alabama to institute a lease sale program in the near future, although there is at least a possibility of a lease sale in State waters during the 40-year cumulative activities scenario for OCS activity following a CPA proposed action.

Florida

Gulf Oil drilled the first offshore exploration wells in Florida in 1947; these wells were in Florida Bay south of Cape Sable in Monroe County. In 1956, Humble Oil drilled an exploration well in the State waters of Pensacola Bay in Santa Rosa County. All wells drilled in State waters were dry holes. Florida banned drilling in State waters in 1992. In 2005, Florida's Governor Jeb Bush and the Florida Cabinet signed a historic settlement agreement to buy out any existing leases in State waters and to eliminate the potential for oil drilling there. Between 1987 and 1995, Chevron made commercial gas discoveries in the Destin Dome leasing area, which is 25 mi (40 km) south of the western end of the Florida Panhandle in Federal OCS waters. The State of Florida objected to plans to produce the discovery. In May 2002, the

U.S. Government agreed to buy back seven leases from Chevron, Conoco, and Murphy Oil for $115 million and to hold in abeyance any further development of the Destin Dome discovery until 2012. The enactment of the Gulf of Mexico Energy Security Act extended the abeyance of the development of the Destin Dome discovery until 2022 and areas within 100 mi (161 km) of the coastline of the State of Florida.

In April 2009, three committees of the Florida House of Representatives approved a bill that would allow offshore drilling in State waters >3 mi (4.8 km) from the eastern Gulf shore. The bill passed the Florida House in April 2009 but died soon after in the Florida Senate.

BOEM does not expect Florida to institute a lease sale program in the near future, although it is possible that a change in policy could lead to leasing on the OCS or in State waters during the 40-year cumulative activities scenario for OCS activity analyzed in this Supplemental EIS.

Pipeline Infrastructure

A mature pipeline network exists in the GOM to transport oil and gas production from the OCS to shore (**Chapter 4.1.1.23.1**). The network carries oil and gas onshore and inland to refineries and terminals, and a network of pipelines distributes finished products such as diesel fuel or gasoline to and between refineries and processing facilities onshore (Peele et al., 2002, Figure 4.1). Expansion of this network is projected to be primarily small-diameter pipelines to increase the interconnectivity of the existing network and a few major interstate pipeline expansions. Any new larger-diameter pipelines would likely be constructed to support onshore and offshore LNG terminals. Refer to Chapter 3.3.2 of the 2012-2017 WPA/CPA Multisale EIS for information on pipeline infrastructure activities within the State waters of Texas, Louisiana, Mississippi, and Alabama.

3.3.3. Other Major Factors Influencing Offshore Environments

Other influencing factors occur concurrently with OCS activity in the offshore areas of the Gulf Coast States. Some of these factors are (1) dredged material disposal, (2) OCS sand borrowing, (3) marine transportation, (4) military activities, (5) artificial reefs and rigs-to-reefs development, (6) offshore LNG projects, (7) development of gas hydrates, and (8) renewable energy and alternative use.

Cumulative impacts to biological, physical, and socioeconomic resources from these types of non-OCS activities are analyzed in the cumulative impacts analysis sections in **Chapter 4.1** of this Supplemental EIS and in Chapters 4.1.1 and 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

3.3.3.1. Dredged Material Disposal

Dredged material is described in 33 CFR part 324 as any material excavated or dredged from navigable waters of the United States. Materials from maintenance dredging are primarily disposed of offshore on existing dredged-material disposal banks and in ocean dredged-material disposal sites (ODMDS's), which are regulated by USEPA under the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act. Additional dredged-material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by the U.S. Army Corps of Engineers (COE) and relevant State agencies prior to construction.

If funds are available, COE uses dredge materials beneficially for restoring and creating habitat, for beach nourishment projects, and for industrial and commercial development (**Chapter 3.3.4.3**). Virtually all ocean dumping that occurs today is maintenance dredging of sediments from the bottom of channels and bodies of water in order to maintain adequate channel depth for navigation and berthing. There are four small authorized open-water disposal areas in Louisiana and Mississippi along open-water stretches of the main Gulf Intracoastal Waterway (GIWW) between Louisiana and Mississippi: Louisiana Disposal Area 66 (1,593 ac; 645 ha); and Mississippi Disposal Area 65A (1,962 ac; 794 ha), Disposal Area 65B (815 ac; 330 ha), and Disposal Area 65C (176 ac; 71 ha) (U.S. Dept. of the Army, COE, 2010, Table 5). Dredged materials from the GIWW are sidecast at these locations. The ODMDS's utilized by COE in the cumulative activities area include those shown in Table 3-30 of the 2012-2017 WPA/CPA Multisale EIS. Maps on the USEPA's website show the locations for the ODMDS's in Louisiana and Texas (USEPA, 2011).

There are two primary Federal environmental statutes governing dredge material disposal. The Marine Protection, Research, and Sanctuaries Act (also called the Ocean Dumping Act) governs transportation of dredge material for the purpose of disposal into ocean waters. Section 404 of the Clean Water Act governs the discharge of dredged or fill material into U.S. coastal and inland waters. The USEPA and COE are jointly responsible for the management and monitoring of ocean disposal sites. The responsibilities are divided as follows: (1) COE issues permits under the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act; (2) USEPA has lead for establishing environmental guidelines/criteria that must be met to receive a permit under either statute; (3) permits for ODMDS disposal are subject to USEPA review and concurrence; and (4) USEPA is responsible for identifying recommended ODMDS's.

The COE's Ocean Disposal Database reports the amount of dredged material disposed in ODMDS's by district (U.S. Dept. of the Army, COE, 2010). **Table 3-9** shows the quantities of dredged materials disposed of in ODMDS's between 2001 and 2010 by the COE's Galveston and New Orleans Districts.

The New Orleans District dredges an average annual 78 million yd^3 (59,635,279 m^3). Current figures estimate that approximately 38 percent (or 30 million yd^3 [22,936,646 m^3]) of that average is available for the beneficial use of dredge materials program (U.S. Dept. of the Army, COE, 2013). The remaining 62 percent of the total material dredged yearly by COE's New Orleans District is disposed of at placement areas regulated under Section 404 of the Clean Water Act, at ODMDS's, or it is stored in temporary staging areas located inland (e.g., the Pass a Loutre Hopper Dredge Disposal Site at the head of the Mississippi River's main "birdfoot" distributary channel system).

Cumulative Activities Scenario: BOEM anticipates that over the next 40 years the amount of dredged material disposed at ODMDS's will fluctuate but that it will generally follow historical trends of the practice utilized to date by the Galveston and New Orleans Districts. Over the last 10 years, the Galveston District has averaged about 6.9 million yd^3 (5.3 million m^3) of material dredged per year disposed at ODMDS's, while the New Orleans District has averaged about 21.7 million yd^3 (16.6 million m^3) of material dredged per year disposed at ODMDS's. Quantities may decrease slightly as various entities identify additional onshore sites for the beneficial uses of dredged material. The 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention), to which the U.S. is a signatory, requires annual reporting of the amount of materials disposed at sea. The COE prepares the dredged material disposed portion of the report to the International Maritime Organization; these yearly reports are available on the COE's Ocean Disposal Database (U.S. Dept. of the Army, COE, 2010b).

3.3.3.2. OCS Sand Borrowing

If OCS sand is desired for coastal restoration or beach nourishment, BOEM uses the following two types of lease conveyances: a noncompetitive negotiated agreement that can only be used for obtaining sand and gravel for public works projects funded in part or whole by a Federal, State, or local government agency; and a competitive lease sale in which any qualified person may submit a bid. BOEM has issued 38 noncompetitive negotiated agreements, but it has never had a competitive lease sale for OCS sand and gravel resources. The OCS Program continues to focus on identifying sand resources for coastal restoration, investigating the environmental implications of using those resources, and processing noncompetitive use requests.

Since 2003, BOEM has participated in the multiagency Louisiana Sand Management Working Group to identify, prioritize, and define a pathway for accessing sand resources in the near-offshore OCS of Louisiana, an area where competitive space use mainly involves OCS oil and gas infrastructure such as wells, platforms, and pipelines. Table 3-32 of the 2012-2017 WPA/CPA Multisale EIS shows the projected approximate volume of OCS sand uses for coastal restoration projects over the next 5 years. Approximately 76 million yd^3 (58 million m^3) are expected to be needed for coastal restoration projects as reported by the Gulf of Mexico OCS Marine Minerals Program. To visualize such a dimension, this volume of sand could fill the Louisiana Superdome stadium 16.5 times.

BOEM received earmarked funds in 2005 to conduct offshore sand studies to investigate available sources of OCS sand for restoring coastal areas in Louisiana, Texas, Alabama, and Mississippi that were damaged by Hurricanes Katrina and Rita. Sand sources identified through this Agency's cooperative effort with Louisiana will likely serve as the major source of material for the restoration of the barrier islands planned as part of the Louisiana Coastal Area ecosystem restoration study (U.S. Dept. of the

Army, COE, 2004), projects identified in the Louisiana 2012 Coastal Master Plan (State of Louisiana, Coastal Protection and Restoration Authority, 2012a), and projects developed under the *Deepwater Horizon* NRDA and 2012 Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States Act (RESTORE Act) barrier island restoration efforts. The Louisiana Coastal Protection and Restoration Authority and Louisiana State University have undertaken joint efforts, funded in part through BOEM, to identify potential sand resources in the Trinity and Tiger Shoal complex, located in the Vermilion and South Marsh Island leasing areas, and to examine the long-term effects of dredging sand on Ship Shoal, a large potential borrow area about 15 mi (24 km) offshore Isle Dernieres, south-central Louisiana. BOEM also has a cooperative agreement with the Louisiana Geological Survey to conduct an evaluation of sand resources associated with paleochannels offshore Cameron Parish, Louisiana. Meanwhile, the General Lands Office in Texas has collected new geologic and geophysical data to describe potential resources in buried Pleistocene Sabine and Colorado River paleochannels, located offshore Jefferson and Brazoria Counties.

Since the dredging of OCS sand and the associated activities of oceangoing dredge vessels could present some use conflicts on blocks also leased for oil and/gas extraction, BOEM initiated a regional offshore sand management program in Louisiana in 2003, which, over the course of 10 years and several meetings, has developed options and recommendations for an orderly process to manage the competing use of OCS sand resources in areas of existing OCS infrastructure. With input from the Sand Management Working Group, BOEM has developed guidelines for sand resource allocations, maintaining a master schedule of potential sand dredging projects, developing procedures for accessing sand under emergency conditions, and establishing environmental requirements for the use of offshore borrow areas.

No sand leases have ever been issued for OCS sand in the WPA. The following seven leases for OCS sand have been issued in the CPA: (1) Holly Beach, Cameron Parish, Louisiana; (2) the South Pelto test area, Terrebonne Parish, Louisiana; (3) Pelican Island shoreline restoration, Plaquemines Parish, Louisiana; (4) Raccoon Island marsh creation, Terrebonne Parish, Louisiana; (5) St. Bernard Shoals, St. Bernard and Plaquemines Parishes, Louisiana; (6) Ship Shoal in South Pelto Area for Caminada Headland restoration in Lafourche and Jefferson Parishes, Louisiana; and (7) Sabine Bank in West Cameron Area for Cameron Parish shoreline restoration, Cameron Parish, Louisiana. Dredging for the Caminada Headland and Cameron Parish Restoration Projects in South Pelto and West Cameron Areas, respectively, began in August 2013 and is expected to continue through the summer of 2014.

In early 2014, BOEM is expected to issue two new leases in Louisiana: the first is for the *Deepwater Horizon* NRDA Whiskey Island Restoration Project in Terrebonne Parish using sand from Ship Shoal Block 88; and the second is for Phase Two of the Caminada Headland Restoration Project in Lafourche and Jefferson Parishes using sand from South Pelto Blocks 13 and 14. BOEM anticipates that dredging for these projects will begin in late 2014. BOEM is also working with the COE's Mobile District and the National Park Service on the Mississippi Coastal Improvements Program, which will use OCS sand from the Mobile Area for barrier island restoration projects along East and West Ship Islands in the Gulf Island National Seashore. Dredging associated with the Mississippi Coastal Improvements Program will likely begin in late 2014. In July 2013, BOEM began working with NOAA and FWS on a North Breton Island Restoration Project planning proposal that will be included in the forthcoming draft NRDA restoration plan. The North Breton Island Restoration Project (Louisiana) will use sand from the Breton Sound Area to restore shorebird and brown pelican nesting habitat in the Breton National Wildlife Refuge. The U.S. Geological Survey will be conducting sand resource surveys in summer 2014, and it is estimated that dredging for the North Breton Island Restoration Project will begin in late 2015.

BOEM has outlined its responsibility as steward of significant sand resources on the OCS in NTL 2009-G04. That NTL provides guidance for the avoidance and protection of significant OCS sediment resources essential to coastal restoration initiatives in the BOEM Gulf of Mexico OCS Region.

Cumulative Activities Scenario: Over the next 40 years, increased use of OCS sand for Louisiana restoration projects is likely. Currently, no Texas restoration projects have been specifically identified. The boundary between the OCS and Texas State waters (9 nmi [10 mi; 16 km]) allows that some offshore sand is within the jurisdiction of the State; however, the easternmost portion of the shelf in Texas State waters is relatively devoid of beach-quality sand deposits. The Texas General Lands Office, in cooperation with BOEM and the Texas Bureau of Economic Geology, has investigated the potential for use of Heald and Sabine Banks as borrow for beach restoration projects, but it has yet to identify specific projects. With respect to Louisiana, some uncertainty exists as to the amount of offshore OCS sand that will eventually be sought for coastal restoration projects. The Louisiana Coastal Area Ecosystem

Restoration plan potentially may use up to 60 million yd^3 (46 million m^3) (U.S. Dept. of the Army, COE, 2009a). Recently, there has been an increase in requests from Louisiana for State-funded OCS sand resources projects. BOEM anticipates that this growing trend of State-led projects will continue into the future as restoration funding is made available directly to the State through the Coastal Impact Assistance Program, the Gulf of Mexico RESTORE Act, the *Deepwater Horizon* NRDA restoration, and the Gulf of Mexico Energy Security Act.

3.3.3.3. Marine Transportation

Under current conditions, freight and cruise ship passenger marine transportation within the analysis area should continue to grow at a modest rate or remain relatively unchanged based on historical freight and cruise traffic statistics. In 2011, the Port of Houston was the second largest port in the United States, while the Port of New Orleans was the sixth largest. Tankers carrying mostly petrochemicals account for about 60 percent of the vessel calls in the Gulf of Mexico. Dry-bulk vessels including bulk vessels, bulk containerships, cement carriers, ore carriers, and wood-chip carriers accounted for another 17 percent of the vessel calls. The GOM also supports a popular cruise industry. In 2011, there were 149 cruise ship departures from Galveston, 139 cruise ship departures from New Orleans, and 199 cruise ship departures from Tampa (USDOT, MARAD, 2012).

Total port calls, or vessel stops at a port, in the U.S. are increasing as a whole, and total port calls within the GOM are also increasing. Gulf of Mexico port calls represent approximately 32 percent of total U.S. port calls. Trends for GOM port calls relative to total U.S. port calls shows an approximate 3 percent average increase of GOM port calls over the last decade, from 17,673 in 2002 to 22,989 in 2011 (USDOT, MARAD, 2013a) (**Table 3-10**).

Table 3-2 presents the estimated number of vessel trips that would occur as a result of a CPA proposed action. Annual OCS oil- and gas-related vessel traffic due to a CPA proposed action represents a small proportion (<1%) of the total vessel traffic in the GOM (**Chapter 3.1.1.8** of this Supplemental EIS and Chapter 3.1.1.8.4 of the 2012-2017 WPA/CPA Multisale EIS). Annual OCS oil- and gas-related vessel traffic due to cumulative OCS activity represents between 9 and 12 percent of the total traffic in the GOM.

Cumulative Activities Scenario: It is expected that the usage of GOM ports will continue to increase by approximately 3 percent annually over the next 40 years. As such, it is anticipated that port calls by all ship types will be bounded annually by a lower limit of current use and an upper limit of approximately 85,000 vessel port calls.

3.3.3.4. Military Activities

Twelve military warning areas and six Eglin Water Test Areas are located within the Gulf (**Figure 2-2**). Six designated military areas and three Eglin Water Test Areas (EWTA's) that are used for military operations lie wholly or partially within the CPA (**Figure 2-2**). The military warning areas within the CPA total approximately 13.3 million ac (about 23% of the total acreage of the CPA). The EWTA's within the CPA total approximately 7 million ac (about 12% of the total acreage of the CPA). Chapter 3.3.3.4 of the 2012-2017 WPA/CPA Multisale EIS describes military activities within the OCS.

Cumulative Activities Scenario: BOEM anticipates that, over the next 40 years, the military use areas currently designated in the CPA will remain the same and that none of them would be released for nonmilitary use. Over the cumulative activities scenario, BOEM expects to continue to require military coordination stipulations in these areas. The intensity of the military's use of these areas, or the type of activities conducted in them, is anticipated to fluctuate with the military mission needs.

3.3.3.5. Artificial Reefs and Rigs-to-Reefs Development

Artificial reefs have been used along the coastline of the U.S. since the early 19th 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 of the five Gulf Coast States—Texas, Louisiana, Mississippi, Alabama, and Florida—have artificial reef programs and plans.

Most 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's installation in 1942. Currently, approximately 12 percent of the platforms decommissioned in the Gulf OCS have been used in the Rigs-to-Reefs Program. It is anticipated that approximately 10 percent of platforms installed as a result of a WPA or CPA proposed action would be converted to a reef after decommissioning. This factor is prompting increased public attention on the ecologic value of oil and gas structures for their reef effects. Ongoing studies aim at evaluating the ecology of offshore structures and may lead to a greater emphasis on the creation of artificial reefs through the Rigs-to-Reefs Program. At present, Texas, Louisiana, and Mississippi participate in the Rigs-to-Reefs Program.

CPA Proposed Actions Scenario (Typical Lease Sale): The number of platform removals projected for a CPA proposed action is 35-67 (**Table 3-2** of this Supplemental EIS and Table 3-3 of the 2012-2017 WPA/CPA Multisale EIS). The number of rigs anticipated to enter the Rigs-to-Reefs Program as a result of a CPA proposed action is approximately 10 percent of the projected removals, or 3-7 in the CPA.

OCS Program Scenario: Over the course of the 40-year cumulative activities scenario for the OCS Program (2012-2051), BOEM projects that a total of 1,279-1,837 platforms will be removed (**Table 3-3**). If approximately 10 percent of these structures are accepted into the Rigs-to-Reefs Program, there may be as many as 128-184 additional artificial reefs installed in the WPA, CPA, and EPA. Note that offshore and onshore impact-producing factors and scenarios associated with a WPA or an EPA proposed action (i.e., a typical lease sale that would result from a proposed action within the WPA or EPA) as well as OCS Program activity resulting from past and future lease sales in the WPA or EPA, are disclosed in the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, WPA 238/246/248 Supplemental EIS, and EPA 225/226 EIS.

3.3.3.6. Offshore Liquefied Natural Gas Projects and Deepwater Ports

There are currently no LNG terminals operating on the OCS in the GOM. The following provides updates to the status of LNG projects and deepwater ports in the GOM as provided in Chapter 3.3.3.6 of the 2012-2017 WPA/CPA Multisale EIS.

Louisiana

Gulf Gateway Energy Bridge. On February 22, 2012, Excelerate Energy notified the U.S. Department of Transportation's Maritime Administration (MARAD) and the USCG of its intention to decommission the Gulf Gateway Energy Bridge deepwater port, the only operational LNG terminal operation on the OCS in the GOM. Excelerate's decision to decommission the facility was due to irreparable hurricane damage to pipelines interconnecting with the deepwater port and a changing natural gas market, which impacted the operator's ability to receive consistent shipments. After careful review and evaluation of the proposed removal plans, MARAD and other Federal agencies authorized Excelerate's decommissioning program for the Gulf Gateway Energy Bridge deepwater port (USDOT, MARAD, 2013b).

Main Pass Energy Hub. Due to significant financial challenges over the past several years, Freeport McMoRan was unable to comply with the conditions of the Record of Decision. As such, on January 2, 2012, MARAD moved forward to rescind approval of the Record of Decision for the Freeport McMoRan project (USDOT, MARAD, 2013b).

Texas

Texas Offshore Port System. On April 12, 2010, the applicant submitted a letter to MARAD to withdraw its application due to its inability to secure necessary financing. The MARAD, in a letter dated May 5, 2010, acknowledged Texas Offshore Port System's withdrawal and, thereafter, terminated the application and all processing activities. This project remains closed with MARAD (USDOT, MARAD, 2013c).

Florida

Port Dolphin. On March 29, 2007, Port Dolphin Energy LLC filed an application with MARAD to construct a deepwater port located in Federal waters approximately 28 mi (45 km) offshore of Tampa, Florida. The applicant is a wholly-owned subsidiary of Höegh LNG. The proposed port will consist of two submerged turret loading buoys similar to those used in the Northeast Gateway and Neptune projects. On October 26, 2009, MARAD issued a Record of Decision approving, with conditions, the Port Dolphin Energy Deepwater Port License application, and on April 19, 2010, the official license was issued. Port Dolphin is currently working with the relevant Federal and State of Florida agencies to obtain the required authorizations and permits for construction and operation of the facility. Construction of the Port Dolphin facility commenced in late 2013 (USDOT, MARAD, 2013b).

3.3.3.7. Development of Gas Hydrates

Gas hydrates are a unique, energy-rich, and poorly understood class of chemical substances in which molecules of one material (in this case solid-state water ─ ice) form an open lattice that physically encloses molecules of a certain size (in this case ─ methane) in a cage-like structure without chemical bonding (Berecz and Balla-Achs, 1983; Henriet and Mienert, 1998; Collett, 2002). The DOE and cooperating agencies have conducted a multiyear characterization program of naturally occurring methane hydrates (gas hydrates) in the GOM. The first cruise for characterizing GOM gas hydrates took place in 2005, and the second took place in 2009. The following provides an update to the Joint Industry Project (JIP) information in Chapter 3.3.3.7 of the 2012-2017 WPA/CPA Multisale EIS.

> Following the events of the *Deepwater Horizon* incident in the Gulf of Mexico, the conditions and requirements for drilling operations in the Gulf of Mexico underwent a dramatic change that resulted in a substantial and detailed evaluation of what is plausible (and affordable) during the remainder of the project. As a result of this evaluation, the JIP and DOE have determined to focus the remainder of the project on the development and testing of an integrated suite of pressure coring and pressure core handling and analysis devices in collaboration with research and development experts from government, academia, and industry. The coring tools will have the flexibility to be used from various platforms in future DOE marine hydrate research expeditions. A decision has been made that a Leg III drilling / pressure coring expedition will not be conducted as part of this project (USDOE, National Energy Technology Laboratory, 2013a).

Methodologies for the extraction and production of gas hydrates are being developed in a collaborative field trial between ConocoPhillips-Japan Oil, Gas, and Metals National Corporation and DOE at the Iġnik Sikumi well site in Alaska. The Iġnik Sikumi gas hydrate test well was drilled and logged during the winter of 2010/2011, and gas hydrate production testing was carried out there during the winter of 2011/2012. A production method was tested by injecting a combination of carbon dioxide and nitrogen gas into the methane hydrate reservoir. The injection phase was followed by an extended period of depressurization and flowback of gas (including methane) to the surface. The data from this study are still being analyzed, but the effort represents the first extraction of methane gas (USDOE, National Energy Technology Laboratory, 2013b). A multiyear project is also being led by the Japan Oil, Gas, and Metals National Corporation and Japan's National Institute of Advanced Industrial Science and Technology and in collaboration with the U.S. Geological Survey's Gas Hydrates Project, researchers from Georgia Tech, DOE, and the JIP in Japan. In 2012, researchers retrieved and preserved pressurized sediment cores containing gas hydrates from the Nankai Trough offshore Japan. These researchers are also conducting the first offshore production test to track how much methane can be released from deepwater gas hydrate deposits (USDOI, GS, 2013). The development of offshore production methods is essential to gas hydrate production methods in the Gulf of Mexico.

This does not change BOEM's anticipation that, within 40 years, it is likely that the first U.S. domestic production from gas hydrates may occur in Alaska, where gas obtained from onshore hydrates will either support local oil and gas field operations or be available for commercial sale if and when a gas pipeline is constructed to the lower 48 states. However, Moridis et al. (2008) stated that it is not possible to discount the possibility that the first U.S. domestic production of gas hydrates could occur in the GOM. Despite the substantially increased complexity and cost of offshore operations, there is a mature network of available pipeline capacity and easier access to markets in the Gulf of Mexico.

3.3.3.8. Renewable Energy and Alternative Use

The two primary categories of renewable energy that have the potential for development in the coastal and OCS waters of the U.S. are (1) wind turbines and (2) marine hydrokinetic systems. Chapter 3.3.3.8 of the 2012-2017 WPA/CPA Multisale EIS describes renewable energy and alternative use programs and potential action within the OCS.

3.3.4. Other Major Factors Influencing Coastal Environments

The GOM is a dynamic, constantly changing system where natural and human-caused factors simultaneously impact both the coastal areas of the Gulf Coast States and OCS activities. These factors include (1) sea-level rise and subsidence, (2) Mississippi Delta hydromodification, (3) maintenance dredging and Federal channels, and (4) coastal restoration programs.

Cumulative impacts to biological, physical, and socioeconomic resources from these types of non-OCS activities are analyzed in the cumulative impacts analysis sections of **Chapter 4.1** of this Supplemental EIS and Chapters 4.1.1 and 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

3.3.4.1. Sea-Level Rise and Subsidence

As part of the Mississippi River's delta system, both the Delta Plain and the Chenier Plain of the Louisiana Coastal Area (LCA) are experiencing relatively high rates of subsidence. All coastlines of the world have been experiencing a gradual absolute rise of sea level that is based on measurements across the globe and that extends across the influence of a single sedimentary basin. There are two aspects of sea-level rise during the past 10,000 years (Holocene Epoch): absolute sea-level rise and relative sea-level rise. Absolute sea-level rise refers to a net increase in the volume of water in the world's oceans. Relative sea-level rise refers to the appearance of sea-level rise, a circumstance where subsidence of the land is taking place at the same time that an absolute sea-level change may be occurring. Geologists tend to consider all sea-level rise as relative because the influence of one or the other is difficult to separate over geologic timeframes.

An absolute sea-level rise would be caused by the following two main contributors to the volume of ocean water on the Earth's surface: (1) change in the volume of ocean water based on temperature; and (2) change in the amount of ice locked in glaciers, mountain ice caps, and the polar ice sheets. For the period 1961-2003, thermal expansion of the oceans accounts for only 23 ± 9 percent of the observed rate of sea-level rise (Bindoff et al. 2007); the remainder is water added to the oceans by melting glaciers, ice caps, and the polar ice sheets. The measurement of sea-level rise over the last century is based on tidal gauges and, more recently, satellite observations, which are not model-dependent. Projections for future sea-level rise are dependent on temperature. As determined by an analysis of air bubbles trapped in Antarctic ice cores, today's atmospheric concentration of CO_2 is the highest it has ever been over the last 2.1 million years (Karl et al., 2009; Luthi et al., 2008; Hönisch et al., 2009). Although the measured data for atmospheric CO_2 concentration or temperatures measurements since the Industrial Revolution are generally not in dispute, proxy data for climates of the geologic past are a source of debate, and the models constructed to make projections for how climate may change remain controversial. Climate models are very sophisticated, but they may not account for all variables that are important or may not assign to modeled variables the weight of their true influence.

The Intergovernmental Panel on Climate Change (IPCC) reported that, since 1961, global average sea level (mean sea level) has risen at an average rate of 1.8 millimeter/year (mm/yr) (0.07 in/yr) and, since 1993, at 3.1 mm/yr (0.12 in/yr) (Bindoff et al. 2007). With updated satellite data to 2010, Church and White (2011) show that satellite-measured sea levels continue to rise at a rate close to that of the upper range of the IPCC projections (IPCC, 2012). It is unclear whether the faster rate for 1993-2010 reflects decadal variability or an increase in the longer-term trend. In the structured context used by the IPCC, there is high confidence that the observed sea-level rise rate increased from the 19th to the 20th century. The average global rate for the 20th century was determined by Bindoff et al. (2007) to be 1.7 ± 0.5 mm/yr (0.066 ± 0.02 in) and the total 20th-century average rise is estimated to be 0.17 m (0.55 ft) (Bindoff et al. 2007). The U.S. Global Change Research Program reported that over the last 50 years sea level has risen up to 8 in (203 mm) along parts of the Atlantic and Gulf Coasts, which included Louisiana and Texas (Karl et al., 2009), and that global sea level is currently rising at an increasing rate.

Although absolute sea-level rise is a contributor to the total amount of sea-level rise along the Gulf Coast, subsidence is the most important contributor to the total. In comparison to other areas along the Gulf Coast, Louisiana's Mississippi Delta and Chenier Plains are built of young sediments deposited over the last 7,000 years. These deltaic sediments have been undergoing compaction and subsidence since they were deposited. The land is sinking at the same time that sea level is rising, contributing to high rates of relative sea-level rise along the Louisiana coast. Blum and Roberts (2009) posited four scenarios for subsidence and sea-level rise, and they concluded sediment starvation alone would cause approximately 2,286 mi^2 (592,071 ha) of the modern delta plain to submerge by 2100, without any other impacting factors contributing to land loss.

A general value of approximately 6 mm/yr (0.23 in/yr) of subsidence from sediment compaction, dewatering, and oxidation of organic matter (Meckel et al., 2006; Dokka, 2006) is a reasonable rate to attribute to the LCA, with the understanding that subsidence rates along the Louisiana coast are spatially variable and influenced by subsurface structure and the timing and manner that the delta was deposited. It is an oversimplification of a complex system when applied to the entire coast, but it is an estimate that is reasonable based on recent data.

Stephens (2009 and 2010a) reported that the influence of subsurface structure has not been taken into account in subsidence assessments in the LCA and along the Gulf Coast (Stephens, 2009, page 747). Most workers studying the effects of subsidence along the LCA have focused on surficial or near-surface geologic data sources and have made no attempt to integrate basin analysis into planning for coastal restoration or flood control project planning.

Results from the National Assessment of Coastal Vulnerability to Sea Level Rise estimate the rate of sea-level rise in the GOM, in particular the areas around Eugene Island, Louisiana, to be the highest (~9.6 mm/yr; 0.38 in/yr) in the United States (Pendleton et al., 2010). This classification is based upon variables such as coastal geomorphology, regional coastal slope, rate of sea-level rise, wave and tide characteristics, and historical shoreline change rates. As much as 88 percent of the northern GOM falls within the high vulnerability category. Areas ranked as very low vulnerability category still have some sea-level rise (1.38 mm/yr [0.054 in/yr] at Apalachicola, Florida). Given this range, BOEM anticipates that, over the next 40 years, the northern GOM will likely experience a minimum relative sea-level rise of 55.2 mm (2.17 in) and a maximum relative sea-level rise of 384 mm (15.1 in). Sea-level rise and subsidence together have the potential to affect many important areas, including the OCS oil and gas industry, waterborne commerce, commercial fishery landings, and important habitat for biological resources (State of Louisiana, Coastal Protection and Restoration Authority, 2012a). Oil and gas infrastructure located within 15 in (381 mm) of the highest high tide in coastal areas along the Gulf could potentially be affected by sea-level rise during this program. Refer to **Chapter 4.1.1.23.1** for sea-level rise effects to land use and infrastructure associated with the OCS Program. Programmatic aspects of climate change relative to the environmental baseline for the Gulf of Mexico OCS Program are discussed in Appendix G.3 of the 2012-2017 WPA/CPA Multisale EIS.

Formation Extraction and Subsidence

Extracting fluids and gas from geologic formations can lead to localized subsidence at the surface. The Texas Gulf of Mexico coast is experiencing high (5-11 mm/yr; 0.19-0.43 in/yr) rates of relative sea-level rise that are the sum of subsidence and eustatic (absolute) sea-level rise (Sharp and Hill, 1995). Even higher rates are associated with areas of groundwater pumping from confined aquifers. Berman (2005, Figure 3) reported that 2 m (6 ft) of subsidence had occurred in the vicinity of the Houston Ship Channel by the mid-1970's as a result of groundwater withdrawal.

Morton et al. (2005) examined localized areas or "hot spots" corresponding to fields in the LCA where oil, gas, and brine were extracted at known rates. Morton et al. (2005) shows measured subsidence along transects across these fields that range from 4 to 18 mm/yr (0.15 to 0.7 in/yr), with the greatest rates tending to coincide with the surface footprints of oil or gas fields. Mallman and Zoback (2007) interpreted downhole pressure data in several Louisiana oil fields in Terrebonne Parish and found localized subsidence over the fields is consistent with theoretically expected reservoir compaction; however, they could not explain the entirety of localized rates to the subsidence rates measured and observed on a regional scale.

Dokka (2011) suggests that the magnitude of deep subsidence in urban New Orleans, an area that has limited oil and gas production, is too large to be explained by any combination of faulting, deep compaction, and lithospheric loading alone. Dokka proposes that the residual subsidence is caused largely due to local and regional groundwater withdrawal, causing as much as 0.8 m (2.6 ft) of subsidence since around 1960.

Down-to-the-basin faulting, also called listric or growth faulting, is a long recognized fault style along deltaic coastlines, and the Mississippi Delta is no exception (Dokka et al., 2006; Gagliano, 2005a). There is currently disagreement in the literature regarding the primary cause of modern fault movement in the Mississippi Delta region, and the degree to which it is driven by fluid withdrawal or sediment compaction resulting from the sedimentary pile pressing down on soft, unconsolidated sediments that causes downward and toward the basin movement along surfaces of detachment in the shallow and deep subsurface.

Berman (2005) discussed the conclusions of Morton et al. (2005) and believed that they failed to make the case that hydrocarbon extraction caused substantial subsidence over the broader area of coastal Louisiana, a conclusion also reached by Gagliano (2005b).

Oil production on the LCA peaked at 513 MMbbl in 1970 and gas production peaked at 7.8 million cubic feet (MMcf) in 1969 (Ko and Day, 2004). From the peak, the level of production activity is slowly decreasing. The magnitude of subsidence caused by formation extraction is a function of how pervasive the activity is across the LCA. The oil and gas field maps in Turner and Cahoon (1987) and Ko and Day (2004) seem an adequate basis to estimate the LCA's oil- and gas-field footprint at ~20 percent of the land area. The amount of subsidence from formation extraction is also occurring on a delta platform that is experiencing natural subsidence and sea-level rise. Fluid and gas extraction may lead to high local subsidence on the scale of individual oil and gas fields but not as a pervasive contributor to regional subsidence across the LCA.

3.3.4.2. Mississippi River Hydromodification

The Mississippi River has been anchored in place by engineered structures built in the 20th century and has been hydrologically isolated from the delta it built. The natural processes that allowed for the river to flood and distribute alluvial sediments across the delta platform and for channels to meander have been shut down. Hydromodifying interventions include construction of (1) levees along the river and distributary channel systems, (2) upstream dams and flood control structures that impound sediment and meter the river flow rate, and (3) channelized canals with earthen or armored banks. Once the natural processes that act to add sediment to the delta platform to keep it emergent are shut down, subsidence begins to outpace deposition of sediment.

Of total upstream-to-downstream flow, the Old River Control Structure (built 1963) diverts 70 percent of flow down the levee-confined channels of the Mississippi River and 30 percent down the unconfined Atchafalaya River, which has been actively aggrading its delta plain since 1973 (LaCoast.gov, 2011). Blum and Roberts (2009) reported that the time-averaged sediment load carried by the Mississippi and Atchafalaya Rivers before installation of the Old River Control Structure was ~400-500 million tons per year and that the average suspended load available to either river after construction of the Old River Control Structure was ~205 million tons per year (Blum and Roberts, 2009, Figure 2). Modern sediment loads are, therefore, less than half that required to build and maintain the modern delta plain, a figure largely in agreement with previous work reporting decreases in suspended sediment load of nearly 60 percent since the 1950's (Turner and Cahoon, 1987, Figure 3-8; Tuttle and Combe, 1981).

Blum and Roberts (2009) posited four scenarios for subsidence and sea-level rise, and concluded sediment starvation alone would cause approximately 2,286 mi^2 (592,071 ha) of the modern delta plain to submerge by 2100 without any other impacting factors contributing to landloss. The use of sediment budget modeling, a relatively new tool for landloss assessment, appears to indicate that hydrographic modification of the Mississippi River has been the most profound man-caused influence on landloss in the LCA. Sediment starvation of the deltaic system is allowing rising sea level and subsidence to outpace the constructive processes building and maintaining the delta.

BOEM anticipates that, over the next 40 years, there might be minor sediment additions resulting from new and continuing freshwater diversion projects managed by COE. Of the 196 projects in the 1990 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program (LaCoast.gov, 2013), 8 involve the introduction of sediment or the reestablishment of natural water and sediment flow regimes to allow the delta plain to replenish and build up, 9 are freshwater diversion projects, 8 are outfall management, 3 are sediment diversion, and 49 are marsh creations. Insofar as these projects represent land additions to the LCA, they are already accounted for in the discussion below under coastal restoration programs.

3.3.4.3. Maintenance Dredging and Federal Channels

Along the Texas Gulf Coast there are eight federally maintained navigation channels in addition to the GIWW. Most of the dredged materials from the Texas channels have high concentrations of silt and clay. Beneficial uses of dredged material include beach nourishment for the more sandy materials, and storm reduction projects or ocean disposal for much of the finer-gained material. Ocean disposal locations along the Texas coast are situated so that materials are placed on the down drift side of the channel (U.S. Dept. of the Army, COE, 1992).

Maintenance dredging activity from 2001 through 2010 for Federal channels by COE's Galveston District are reported in COE's Ocean Disposal Database (U.S. Dept. of the Army, COE, 2011) (**Table 3-11**). **Table 3-12** shows the same information for Federal channels in Louisiana, and **Table 3-13** shows the same information for Federal channels in Mississippi, Alabama, and Florida.

There are 10 Federal navigation channels in the LCA, ranging in depth from 4 to 14 m (12 to 45 ft) and in width from 38 to 300 m (125 to 1,000 ft), that were constructed as public works projects beginning in the 1800's (Good et al., 1995, Table 1). The Federal navigation channels in Louisiana identified by Good et al. (1995, Table 1) are as follows: (1) GIWW East of the Mississippi River; (2) Mississippi River Gulf Outlet; (3) GIWW between the Atchafalaya and Mississippi Rivers; (4) GIWW West of the Atchafalaya River; (5) Barataria Bay Waterway; (6) Bayou Lafourche; (7) Houma Navigation Canal; (8) Mermentau Navigation Channel; (9) Freshwater Bayou; and (10) Calcasieu River Ship Channel. The Mississippi River Gulf Outlet has been decommissioned and sealed with a rock barrier as of July 2009 (Shaffer et al., 2009, page 218).

Turner and Cahoon (1987, Table 4-1) and DOI (Table 3-14 of the 2012-2017 WPA/CPA Multisale EIS) identified OCS oil- and gas-related channels that bore traffic supporting the OCS Program. Between these works and Good et al. (1995, Table 1), channel names do not well agree and a comparison is difficult. No channel is exclusively used by OCS Program traffic and only a fraction of the total traffic is attributable to OCS use, i.e., approximately 10-13 percent. BOEM compiled Table 3-37 of the 2012-2017 WPA/CPA Multisale EIS using the information in industry plans to show that, between 2003 and 2008, the vast majority (80-90%) of OCS service vessels used service-base facilities in the LCA that are located along rivers or that lie within wetlands that are already saline or brackish. Table 3-37 of the 2012-2017 WPA/CPA Multisale EIS shows that the contribution of OCS Program traffic to bank degradation and freshwater wetland loss is minimal.

The GIWW is a Federal, shallow-draft navigation channel constructed to provide a domestic connection between Gulf ports after the discovery of oil in East Texas in the early 1900's, as well as to provide a pathway to support the growing need for interstate transport of steel and other manufacturing materials in the early 20th century. It extends approximately 1,400 mi (2,253 km) along the Gulf Coast from St. Marks in northwestern Florida to Brownsville, Texas, with the Louisiana part reported to be 994 mi (1,600 km) in length (Good et al., 1995). With the exception of the east-west GIWW in Louisiana, Federal channels are approximately north-south in orientation, making them vulnerable to saltwater intrusion during storms.

Direct cumulative impacts include the displacement of wetlands by original channel excavation and disposal of the dredged material. Good et al. (1995) estimated that direct impacts from the construction of Federal navigation channels were between 58,000 and 96,000 ac (23,472 and 38,850 ha). Indirect cumulative landlosses resulted from hydrologic modifications, saltwater intrusion, or bank erosion from vessel wakes (Wang, 1988). Once cut, navigation canals tend to widen as banks erode and subside, depending on the amount of traffic using the channel. Good et al. (1995, Table 1) estimated indirect impacts on wetland loss from bank erosion at 35,000 ac (14,164 ha).

The COE reported that the New Orleans District has the largest channel maintenance dredging program in the U.S., with an annual average of 70 million yd^3 (53.5 million m^3) of material dredged (U.S. Dept. of the Army, COE, 2009a). Of that total, COE's Ocean Disposal Database indicates that the New Orleans District has averaged about 21.7 million yd^3 (16.6 million m^3) of material dredged per year disposed at ODMDS's over the last 10 years (U.S. Dept. of the Army, COE, 2010a) (**Chapter 3.3.3.1**). Federal channels and canals are maintained throughout the onshore cumulative impact area by COE, State, county, commercial, and private interests. Proposals for new and maintenance dredging projects are reviewed by Federal, State, and local agencies as well as by private and commercial interests to identify and mitigate adverse impacts upon social, economic, and environmental resources.

Maintenance dredging is performed on an as-needed basis. Typically, COE schedules surveys every 2 years on each navigation channel under its responsibility to determine the need for maintenance dredging. Dredging cycles may be from 1 to as many as 11 years from channel to channel and from channel segment to channel segment. The COE is charged with maintaining all larger navigation channels in the cumulative activities area. The COE dredges millions of cubic meters of material per year in the cumulative activities area, most of which is under the responsibility of the New Orleans District. Some shallower port-access channels may be deepened over the next 10 years to accommodate deeper draft vessels. Vessels that support deepwater OCS activities may include those with drafts to about 7 m (23 ft).

Construction and maintenance dredging of rivers and navigation channels can furnish sediment for beneficial purpose, a practice the COE calls the beneficial use of dredge materials program. Drilling, production activity, and maintenance at most coastal well sites in Louisiana require service access canals that undergo some degree of aperiodic maintenance dredging to maintain channel depth, although oil and gas production on Louisiana State lands peaked in 1969-1970 (Ko and Day, 2004). In recent years, dredged materials have been sidecast to form new wetlands using the beneficial use of dredge materials program. Potential areas suited for beneficial use of dredge material are considered most feasible within a 10-mi (16-km) boundary around authorized navigation channels in the New Orleans District, but the potential for future long distance pipelines for disposal of dredged material could increase considerably the potential area available for the beneficial use of dredge materials program (U.S. Dept. of the Army, COE, 2009a).

As discussed in **Chapter 3.3.3.1**, COE's New Orleans District dredges an average annual 78 million yd^3 (59,635,279 m^3). Current figures estimate that approximately 38 percent (or 30 million yd^3 [22,936,646 m^3]) of that average is available for the beneficial use of the dredge materials program (U.S. Dept. of the Army, COE, 2013). The COE reported that, over the last 20 years, approximately 12,545 ha (31,000 ac) of wetlands have been created with dredged materials, most of which are located on the LCA delta plain (U.S. Dept. of the Army, COE, 2013).

Cumulative Activities Scenario: The construction of Federal channels is not a growth industry that would lead to future direct taking of wetlands, and at least one Louisiana channel (Mississippi River Gulf Outlet) has been decommissioned and sealed with a rock barrier as of July 2009 (Shaffer et al., 2009). Current research has shown that the erosion of canals has slowed from a widening rate of 1.71 m/yr (5.61 ft/yr) between 1978 and 1998 to 0.99 m/yr (3.25 ft/yr) between 1998 and 2006 (Thatcher et al., 2011). "The mean annual rates of total canal widening or narrowing ranged from -6.47 m/year (-21.23 ft/year) (measured as shoreline retreat) for the Theodore Ship Channel, Alabama, to 2.58 m/year (8.46 ft/year) for the Atchafalaya River, Louisiana (measured as shoreline advancement)" (Thatcher et al., 2011, Table 7). To estimate the effect of vessel traffic on the erosion of navigational canals, 30 percent of all banks were assumed to be armored either by rock rip-rap, degraded rock rip-rap, or with bulkheads (Thatcher et al., 2011).

BOEM conservatively estimates that there are approximately 4,850 km (3,013 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic in the EPA, CPA, and WPA (**Table 3-7**) and that the average canal is widening at a rate of 0.99 m/year (3.25 ft/year). Gulfwide, this results in a total annual landloss of approximately 831 ac/yr (336 ha/yr). Therefore, over the 40-year cumulative activities scenario, landloss in Federal navigation channels could total approximately 33,221 ac (13,444 ha). Total landloss in these areas can be caused by multiple factors, including saltwater intrusion, hurricanes, and vessel traffic. The OCS Program-related traffic constitutes a larger percent of the total vessel traffic (OCS Program-related and non-OCS Program-related) in the CPA (12-16%) than in the WPA (3-5%). All service vessels associated with EPA actions are assumed to use CPA navigational canals while inland and constitute less than 1 percent of the total vessel traffic. Assuming that vessel traffic alone was the sole source of erosion, the rate of landloss would be related to the usage of those canals by both OCS Program-related vessels and other vessel traffic. Using the estimated proportion of OCS Program vessel traffic as a measurement of erosion, BOEM conservatively estimates the OCS Program's contribution to bank erosion over the 40-year cumulative scenario to be 2,766-3,645 ac (1,119-1,475 ha). This number is considered conservative because open waterways were included in the total length of Federal navigation channels, vessel size was not taken into consideration, and there are sources of erosion to navigation canals other than vessel traffic alone.

In the Louisiana Coastal Master Plan (State of Louisiana, Coastal Protection and Restoration Authority, 2012a), it is estimated that up to 1,750 mi^2 (4,500 km^2) of land will be lost in the next 50 years (or approximately 896,000 ac [362,600 ha] of land in the next 40 years). Using BOEM's conservative estimate of approximately 2,360 km (1,470 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic in the LCA (**Table 3-7**) and the average canal widening rate of -0.99 m/yr (-3.25 ft/yr), a total landloss of approximately 16,190 ac (6,550 ha) in navigation canals may be estimated over the next 40 years. Using this estimate and comparing it with the total expected landloss in coastal Louisiana over the next 40 years, BOEM estimates that approximately 2 percent of the total landloss in Louisiana will occur due to salt intrusion, hurricanes, and vessel traffic (OCS Program-related and non-OCS Program-related) in navigation canals. Because OCS Program-related vessel traffic constitutes only 12-16 percent of the total vessel traffic in the CPA, BOEM conservatively estimates that OCS Program-related vessel traffic would contribute <0.5 percent (or <2,647 ac [1,071 ha]) of the landloss in coastal Louisiana in the next 40 years.

Net landloss due to navigation canals alone can be calculated by comparing erosion rates with beneficial activities such as land gained through the use of dredged sands. BOEM anticipates that, over the next 40 years, if current trends in the beneficial use of dredged sand and sediment are simply projected based on past land additions (U.S. Dept. of the Army, COE, 2009b), approximately 50,000 ac (20,234 ha) may be created or protected in the LCA through dredged materials programs. Subtracting projected landlosses of 16,190 ac (6,550 ha) caused by bank widening of navigation channels in the LCA from land added or protected by beneficial uses of dredged material, an estimated net gain of 33,800 ac (13,700 ha) between the years 2013 and 2063 could occur.

For a more complete and detailed discussion of maintenance dredging and Federal channels, refer to Chapter 3.3.4.3 of the 2012-2017 WPA/CPA Multisale EIS. For more information on coastal restoration programs, refer to **Chapter 3.3.4.4** of this Supplemental EIS.

3.3.4.4. Coastal Restoration Programs

The Mississippi Delta sits atop a pile of Mesozoic and Tertiary-aged sediments up to 7.5 mi (12.2 km) thick at the coast and up to 11.4 mi (18.3 km) thick offshore (Gagliano, 1999). Five major deltaic deposition lobes are generally recognized within about the uppermost 50 m (164 ft) of sediments (Britsch and Dunbar, 1993; Frazier, 1967, Figure 1). The oldest lobe contains peat deposits dated as 7,240 years old (Frazier, 1967, page 296). The youngest delta lobe of the Mississippi Delta is the Plaquemines-Balize lobe that has been active since the St. Bernard lobe was abandoned about 1,000 years ago. The lower Mississippi River has shifted its course to the GOM every thousand years or so, seeking the most direct path to the sea while building a new deltaic lobe. Older lobes were abandoned to erosion and subsidence as the sediment supply was shut off. Because of the dynamics of delta building and abandonment, the LCA experiences relatively high rates of subsidence relative to more stable coastal areas eastward and westward (U.S. Dept. of the Army, COE, 2004).

The first systematic program authorized for coastal restoration in the LCA was the 1990 CWPPRA, otherwise known as the "Breaux Act." Individual CWPPRA projects are designed to protect and restore between 10 and 10,000 ac (4 and 4,047 ha), require an average of 5 years to transition from approval to construction, and are funded to operate for 20 years (U.S. Government Accountability Office, 2007), which is a typical expectation for project effectiveness (Campbell et al., 2005).

The 1990 CWPPRA introduced an ongoing program of relatively small projects to partially restore the coastal ecosystem. As the magnitude of Louisiana's coastal landlosses and ecosystem degradation became more apparent, so too appeared the need for a more systematic approach to integrate smaller projects with larger projects to restore natural geomorphic structures and processes. Projects have ranged from small demonstration projects to projects that cost over $50 million. The COE reports that, as of May 2013, there are 196 authorized CWPPRA projects, 99 of which have been completed. Another 20 projects are under construction, 34 are in the engineering and design phase, and 43 have been deauthorized or transferred to another program. The COE projects the creation of over 81,000 "anticipated total acres" (32,780 ha) from constructed projects. Of the 60 projects not yet completed as of mid-2013, COE anticipates that those projects will result in 33,297 anticipated total acres (13,474 ha) (LaCoast.gov, 2013). Of the 99 completed projects listed on LaCoast.gov (2013), more than half were one of three categories types: shoreline protection (29 projects); hydrologic restoration (24 projects); or marsh creation (16 projects). The Coast 2050 Report (State of Louisiana, Dept. of

Natural Resources, 1998) combined previous restoration planning efforts with new initiatives from private citizens, local governments, State and Federal agency personnel, and the scientific community to converge on a shared vision to sustain the coastal ecosystem. The LCA Ecosystem Restoration Study (U.S. Dept. of the Army, COE, 2004) built upon the Coast 2050 Report. The LCA's restoration strategies generally fell into one of the following categories: (1) freshwater diversion; (2) marsh management; (3) hydrologic restoration; (4) sediment diversion; (5) vegetative planting; (6) beneficial use of dredge material; (7) barrier island restoration; (8) sediment/nutrient trapping; and (9) shoreline protection, as well as other types of projects (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2006, Table 1).

Following Hurricanes Katrina and Rita in 2005, an earlier emphasis on coastal or ecosystem restoration of the LCA was reordered to at least add an equal emphasis on hurricane flood protection. The Department of Defense Appropriations Act of 2006 authorized COE to develop a comprehensive hurricane protection analysis to present a full range of flood control, coastal restoration, and hurricane protection measures for south Louisiana (U.S. Dept. of the Army, COE, 2009b). The Appropriations Act required Louisiana to create a State organization to sponsor the hurricane protection and restoration projects that resulted. The State legislature established the Coastal Protection and Restoration Authority and charged it with coordinating the efforts of local, State, and Federal agencies to achieve long-term, integrated flood control and wetland restoration. The Coastal Protection and Restoration Authority developed a comprehensive master plan for a sustainable coast (State of Louisiana, Coastal Protection and Restoration Authority, 2007); this plan served as their vision of an integrated program designed to link what had once been separate areas of activity—flood protection and coastal restoration. The Coastal Protection and Restoration Authority's Annual Plans prioritize the types of projects undertaken each fiscal year. It is not entirely clear how coordination between the State and Federal authorities is undertaken in order to develop the range of projects selected for the State's Coastal Protection and Restoration Authority's Annual Plan and COE's plan (U.S. Dept. of the Army, COE, 2009a).

The Coastal Protection and Restoration Authority released a Final Coastal Master Plan in 2012. The Plan's objectives focus on flood protection, harnessing natural processes, supporting coastal habitats, sustaining cultural heritage, and promoting a working coast (State of Louisiana, Coastal Protection and Restoration Authority, 2012a).

There is no simple way to anticipate the following: (1) which projects the State's Coastal Protection and Restoration Authority will admit to its Annual Plan; (2) which projects (among those undertaken for COE's comprehensive range of plans for flood control, coastal restoration, and hurricane protection measures for the LCA) will feed into the Coastal Protection and Restoration Authority's Annual Plan for authorization; and (3) ultimately which, if any, of the aforementioned projects will be completed. Because these projects are chosen on the basis of annual appropriations, there is no simple way to establish projections for land added or preserved over the cumulative activities scenario.

Coastal Impact Assistance Program

The Energy Policy Act of 2005 was signed into law by President George W. Bush on August 8, 2005. Section 384 of the Energy Policy Act of 2005 amended Section 31 of the OCSLA (43 U.S.C. § 1356(a)) to establish the Coastal Impact Assistance Program (CIAP). Under Section 384, Congress directed the Secretary to disburse $250 million for each of the fiscal years 2007 through 2010 to eligible OCS oil- and gas-producing States and coastal political subdivisions.

The authority and responsibility for the management of CIAP is vested in the Secretary of the Interior; the Secretary delegated this authority and responsibility to BOEM up until September 30, 2011. In 2011, the Secretary announced that FWS would take over administration of CIAP effective October 1, 2011, because the program aligned with FWS's conservation mission and similar grant programs run by FWS. The eligibility requirements for States, coastal political subdivisions, and fundable projects remained largely the same after the transfer.

The CIAP provides Federal grant funds derived from Federal offshore lease revenues to oil-producing states for conservation, protection, and restoration of coastal areas. The CIAP funds can be directed to a number of different projects, including restoration of wetlands; mitigation of damage to fish, wildlife, or natural resources; planning assistance and payment of the administrative costs of complying with these objectives; implementation of a federally approved marine, coastal, or comprehensive conservation management plan; and mitigation of the impact of OCS activities through the funding of onshore infrastructure projects and public service needs.

Eligible CIAP States	Eligible CIAP Coastal Political Subdivisions
Alabama	Baldwin and Mobile Counties
Alaska	Municipality of Anchorage and Bristol Bay, Kenai Peninsula, Kodiak Island, Lake and Peninsula, Matanuska-Susitna, North Slope, and Northwest Arctic Boroughs
California	Alameda, Contra Costa, Los Angeles, Marin, Monterey, Napa, Orange, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, and Ventura Counties
Louisiana	Assumption, Calcasieu, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Mary, St. Tammany, Tangipahoa, Terrebonne, and Vermilion Parishes
Mississippi	Hancock, Harrison, and Jackson Counties
Texas	Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Harris, Jackson, Jefferson, Kenedy, Kleberg, Matagorda, Nueces, Orange, Refugio, San Patricio, Victoria, and Willacy Counties

Natural Resource Damage Assessment Trustee Council

The Oil Pollution Act, as provided in 33 U.S.C. § 2706, allowed the designation of certain Federal agencies, States, and Indian tribes—collectively known as the Natural Resource Damage Assessment Trustee Council (Trustee Council). The Trustee Council is authorized to act on behalf of the public to (1) assess natural resource injuries resulting from a discharge of oil or the substantial threat of a discharge and response activities and (2) develop and implement a plan(s) for restoration of those injured resources (USDOI, 2012). With respect to NRDA for the *Deepwater Horizon* explosion and oil spill, a list of trustees can be found at http://www.gulfspillrestoration.noaa.gov/about-us/co-trustees/. On September 27, 2010, the Trustee Council submitted documentation supporting their determination of jurisdiction and their intent to conduct restoration planning. Executive Order 13554, signed on October 5, 2010, recognized the role of the Trustee Council under the Oil Pollution Act and required that the Gulf Coast Ecosystem Restoration Task Force support the NRDA process by referring potential ecosystem restoration actions to the Trustee Council for consideration. Specifically, Executive Order 13554 recognized the importance of carefully coordinating the work of the Task Force with the Trustee Council, "whose members have statutory responsibility to assess natural resource damages from the Deepwater Horizon Oil Spill, to restore trust resources, and seek compensation for lost use of those trust resources" (The White House, 2012). The Trustee Council is currently in the early restoration phase, and their data collection and analysis are ongoing (USDOI, 2012).

Gulf Coast Ecosystem Restoration Council

The Gulf Coast Ecosystem Restoration Task Force (refer to Chapter 3.3.3.4 of the 2012-2017 WPA/CPA Multisale EIS) was terminated in December 2012, following release of Executive Order 13626 in September 2012 and affirming the Federal Government's Gulf Coast ecosystem restoration efforts in light of the recent passage of the RESTORE Act. The RESTORE Act established a mechanism for providing funding to the Gulf region to restore ecosystems and rebuild local economies damaged by the *Deepwater Horizon* oil spill. Additionally, the RESTORE Act established the Gulf Restoration Council, an independent entity charged with developing a comprehensive plan for ecosystem restoration in the Gulf Coast (Comprehensive Plan), as well as any future revisions to the Comprehensive Plan. This Council replaced the Gulf Coast Ecosystem Restoration Task Force in December 2012.

> Among its other duties, the Gulf Restoration Council is tasked with identifying projects and programs aimed at restoring and protecting the natural resources and ecosystems of the Gulf Coast region, to be funded from a portion of the Trust Fund; establishing such other advisory committees as may be necessary to assist the Gulf Restoration Council, including a scientific advisory committee and a committee to advise the Gulf Restoration

Council on public policy issues; gathering information relevant to Gulf Coast restoration, including through research, modeling, and monitoring; and providing an annual report to the Congress on implementation progress. Consistent with the RESTORE Act, the Comprehensive Plan developed by the Gulf Restoration Council will include provisions necessary to fully incorporate the Strategy, projects, and programs recommended by the Task Force (The White House, 2012).

3.3.5. Natural Events and Processes

Chapter 3.3.5 of the 2012-2017 WPA/CPA Multisale EIS describes in detail natural events and processes in the GOM, including physical oceanography and hurricanes.

Since 2009, most of the extreme atmospheric events in the GOM have been categorized as tropical storms with strong winds, heavy rain, and storm surges causing coastal flooding. However, on August 28, 2012, Hurricane Isaac made landfall in southeastern Louisiana as a Category 1 hurricane. While there were no reports of moderate or extensive damage to offshore oil or gas infrastructure in the GOM, Hurricane Isaac did result in the suspension of small amounts of tarballs and some oil from sediments (Mulagabal et al., 2013). This conforms with predictions in the 2012-2017 WPA/CPA Multisale EIS analysis and is discussed more fully in **Chapter 4.1.1.2.1** of this Supplemental EIS.

CHAPTER 4

DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

4. DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

The impacts of 10 WPA and CPA lease sales were analyzed in the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247, Final Environmental Impact Statement* (2012-2017 WPA/CPA Multisale EIS) (USDOI, BOEM, 2012b and this analysis was updated in the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement* (WPA 233/CPA 231 Supplemental EIS) (USDOI, BOEM, 2013a). An analysis of the routine, accidental, and cumulative impacts of a CPA proposed action on the environmental, socioeconomic, and cultural resources of the GOM can be found in Chapter 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1 of the WPA 233/CPA 231 Supplemental EIS. The 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS are hereby incorporated by reference.

The purpose of this Supplemental EIS is to determine if there are significant new circumstances or information bearing on the proposed actions or their impacts, as stated in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, and, if so, to disclose those changes and conclusions. This includes all relevant new information available since the publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. This Supplemental EIS analyzes the potential impacts of a CPA proposed action on sensitive coastal environments, offshore marine resources, onshore and offshore socioeconomic resources, and cultural resources.

4.1. PROPOSED CENTRAL PLANNING AREA LEASE SALES 235, 241, AND 247

Proposed CPA Lease Sales 235, 241, and 247 are tentatively scheduled to be held in March 2015, 2016, and 2017, respectively. The proposed CPA lease sale area encompasses about 63 million ac of the total CPA area of 66.45 million ac. This area begins 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama, and extends seaward to the limits of the United States' jurisdiction (often the Exclusive Economic Zone) in water depths up to approximately 3,346 m (10,978 ft) (**Figure 1-1**). As of February 2014, approximately 43.5 million ac of the proposed CPA lease sale area are currently unleased. A CPA proposed action would offer for lease all unleased blocks within the proposed CPA lease sale area for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006; and

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

The DOI is conservative throughout the NEPA process and includes the total area within the CPA for environmental review even though the leasing of portions of the CPA (subareas or blocks) can be deferred during a Five-Year Program.

Chapter 4.1.1 presents a brief summary of the baseline data for the physical, biological, and socioeconomic resources that would potentially be affected by a CPA proposed action or the alternatives. For additional information on the baseline data for the physical, biological, and socioeconomic resources that would potentially be affected by a CPA proposed action or the alternatives, refer to Chapter 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS and to updated information provided in Chapter 4.2.1 of the WPA 233/CPA 231 Supplemental EIS.

Chapter 4.1.1 also presents analyses of the potential impacts of routine events, accidental events, and cumulative activities associated with a CPA proposed action or the alternatives on these resources. Baseline data are considered in the assessment of impacts from proposed CPA Lease Sales 235, 241, and 247 on these resources. In addition, **Appendix B** ("Catastrophic Spill Event Analysis") serves as a complement to this chapter and provides additional analysis of the potential impacts of a low-probability catastrophic oil spill, which is not reasonably expected and not part of a CPA proposed action, to the environmental and cultural resources and the socioeconomic conditions analyzed below.

The *Deepwater Horizon* explosion off the Louisiana coast resulted in the largest oil spill in U.S. history. An event such as this has the potential to adversely affect multiple resources over a large area. The level of adverse effect depends on many factors, including the sensitivity of the resource as well as the sensitivity of the environment in which the resource is located. All effects may not initially be seen and some could take years to fully develop. The following analyses of impacts from the *Deepwater Horizon* explosion, oil spill, and response on the physical, biological, and socioeconomic resources are based on post-*Deepwater Horizon* credible scientific information that was publicly available at the time this document was prepared. This credible scientific information was applied using accepted methodologies, including numerical modeling of data and scientific writing methods to convey the information of BOEM's subject-matter experts' technical knowledge and experience. However, the Trustee Council of the NRDA for the *Deepwater Horizon* oil spill continues to study, measure, and interpret impacts arising out of that spill. Because the NRDA information has not yet been made available to BOEM or the general public, there are thus instances in which BOEM is faced with incomplete and unavailable information that may be relevant to evaluating reasonably foreseeable significant adverse impacts on the human environment. While incomplete or unavailable information could conceivably result in potential future shifts in baseline conditions of habitats that could affect BOEM's decisionmaking, BOEM has determined that there is sufficient basis to proceed with this Supplemental EIS while operating on the basis of the most current available data and expertise of BOEM's subject-matter experts. **Chapter 4.1.1 and Appendix B** provide a summary of existing credible scientific evidence related to this issue and BOEM's evaluation of potential impacts based upon theoretical approaches or research methods generally accepted in the scientific community. Despite the unavailability of complete information from the NRDA process, BOEM has determined that it can make an informed decision even without this incomplete and unavailable information because BOEM utilizes the best available scientifically credible information in its decisionmaking process and because, although BOEM cannot speculate as to the results of ongoing NRDA studies, BOEM experts can apply other scientifically credible information using accepted theoretical approaches and research methods, such as information on related or surrogate species. Moreover, BOEM will continue to monitor these resources for effects caused by the *Deepwater Horizon* explosion, oil spill, and response, and will ensure that future BOEM environmental reviews take into account any new information that may emerge.

Chapter 3.2.1 of this Supplemental EIS provides a brief summary of the 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. Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS provides the number of spills ≥1,000 bbl and <1,000 bbl estimated to occur as a result of a CPA proposed action. BOEM estimates that the mean number of spills ≥1,000 bbl for a CPA proposed action is <1-1 spill. Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS provides spill rates for several spill-size categories. Chapter 3.2.1.8 and Figures 3-8 through 3-28 of the 2012-2017 WPA/CPA Multisale EIS describe the probabilities of a spill ≥1,000 bbl occurring and contacting modeled environmental resources. For additional 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, refer to **Chapter 3.2.1** of this Supplemental EIS and to Chapter 3.2.1 of the 2012-2017 WPA/CPA Multisale EIS.

Analytical Approach

The analyses of potential effects to the wide variety of physical, environmental, and socioeconomic resources in the vast area of the GOM and adjacent coastal areas is very complex. Specialized education, experience, and technical knowledge are required, as well as familiarity with the numerous impact-producing factors associated with oil and gas activities and other activities that can cause cumulative impacts in the area. Knowledge and practical working experience of major environmental laws and regulations such as NEPA, the Clean Water Act, Clean Air Act, Coastal Zone Management Act (CZMA), Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), the Magnuson-Stevens Fishery Conservation and Management Act, and others are also required.

In order to accomplish this task, BOEM has assembled a multidisciplinary staff with hundreds of years of collective experience. The vast majority of this staff has advanced degrees with a high level of knowledge related to the particular resources discussed in this chapter. This staff prepares the input to BOEM's lease sale EIS's, a variety of subsequent postlease NEPA reviews, and are also involved with

ESA, essential fish habitat (EFH), and CZMA consultations. In addition, this same staff is also directly involved with the development of studies conducted by BOEM's Environmental Studies Program. The results of these studies feed directly into our NEPA analyses.

For this Supplemental EIS, BOEM developed a set of assumptions and a scenario, and described the impact-producing factors that could occur from routine oil and gas activities, as well as accidental events. These assumptions, scenario, and factors are summarized in **Chapter 3** of this Supplemental EIS and are discussed in detail in Chapter 3 of the 2012-2017 WPA/CPA Multisale EIS. On the basis of these assumptions, scenario, and factors, BOEM's multidisciplinary staff applies its knowledge and experience to analyze the potential effects that could arise out of proposed CPA Lease Sales 235, 241, and 247.

For most resources, the conclusions developed by BOEM's subject-matter experts regarding the potential effects of proposed CPA Lease Sales 235, 241, and 247 are necessarily qualitative in nature; however, these conclusions are based on the expert opinion and judgment of highly trained subject-matter experts. BOEM's staff approaches this effort in good faith utilizing credible scientific information including, but not limited to, information available since the *Deepwater Horizon* explosion, oil spill, and response, and applying this information using accepted methodologies, including numerical modeling of data and scientific writing methods to convey the information of the subject-matter experts' technical knowledge and experience. It must also be emphasized that, in arriving at the overall conclusions for certain environmental resources (e.g., coastal and marine birds, fisheries, and wetlands), the conclusions are not based on impacts to individuals, small groups of animals, or small areas of habitat, but on impacts to the resources/populations as a whole. Where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives. If BOEM's subject-matter experts determined that the incomplete or unavailable information was essential, BOEM made good faith efforts to acquire the information. In the event that BOEM was unable to obtain essential information due to either impossibility or exorbitant cost, BOEM applied accepted scientific methodologies in place of that information. This approach is described in the next subsection on "Incomplete or Unavailable Information."

Over the years, BOEM has developed a suite of lease stipulations and mitigating measures to eliminate or ameliorate potential environmental effects. In many instances, these lease stipulations and mitigating measures were developed in coordination with other natural resource agencies such as NMFS and FWS.

Throughout its effort to prepare this Supplemental EIS, BOEM has made painstaking efforts to comply with the spirit and intent of NEPA, to avoid being arbitrary and capricious in its analyses of potential environmental effects, and to use adaptive management to respond to new developments related to the OCS Program.

Incomplete or Unavailable Information

In the following analyses of physical, environmental, and socioeconomic resources, BOEM identifies situations in which its analysis contains incomplete or unavailable information. The major area where BOEM is faced with incomplete or unavailable information is in relation to the *Deepwater Horizon* explosion, oil spill, and response. Information related to the explosion, oil spill, and response is still being collected, interpreted, and analyzed by a myriad of Federal and State agencies. With respect to some of this information, including much of the data related to the NRDA process, those in charge of analyzing impacts from the spill have not yet shared their data and findings with BOEM or made this information publicly available. Therefore, in situations in which BOEM's subject-matter experts were faced with incomplete or unavailable information, the subject-matter experts for each resource utilized the most recent publicly available, scientifically credible information from other sources to support the conclusions contained in this Supplemental EIS. This information is identified and summarized in **Chapter 4.1.1** of this Supplemental EIS and is discussed in detail for each resource in Chapter 4.2.1 of the 2012-2017 WPA/CPA Multisale EIS. In certain circumstances, identified and described in more detail in **Chapter 4.1.1** of this Supplemental EIS, BOEM's subject-matter experts were required to utilize accepted methodologies to extrapolate conclusions from existing or new information and to make reasoned estimates and developed conclusions regarding the current CPA baseline for resource categories and expected impacts from a CPA proposed action given any baseline changes. For reasons described below, there are no changes to the conclusions presented in the 2012-2017 WPA\CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

It is important to note that, barring another catastrophic oil spill, which is a low-probability accidental event, the adverse impacts associated with a proposed CPA lease sale are small, even in light of the *Deepwater Horizon* explosion, oil spill, and response. This is because of draft lease sale stipulations and BOEM and other Federal and State entities' mitigating measures. BOEM also imposes site-specific mitigations that become conditions of plan or permit approval at the postlease stage. Collectively, these measures further reduce the likelihood of adverse impacts.

For the following resources, as with the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, the subject-matter experts determined that there is incomplete or unavailable information that is relevant to reasonably foreseeable significant adverse impacts; however, it is not essential to a reasoned choice among alternatives.

- *Physical Resources in the CPA*: Physical resources (i.e., water quality and air quality) within the CPA are likely not continuing to be affected to any discernible degree by the *Deepwater Horizon* explosion, oil spill, and response, based on the best available information, including recent sampling data. Although unable to speculate as to the results of ongoing NRDA studies, BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives because BOEM utilizes the best available scientifically credible information in its decisionmaking process. Much of the information related to the *Deepwater Horizon* explosion, oil spill, and response may not be available for some time, regardless of the costs necessary to obtain this information, as there are numerous task forces and interagency groups involved in the production of the information. It is not expected that this data would become publicly available in the near term, and certainly not within the timeline contemplated in the NEPA analysis of this Supplemental EIS.
- *Nonmobile Biological Resources within the CPA*: Coastal and offshore biological and benthic habitats (i.e., barrier beaches, wetlands, seagrasses, soft bottom benthic communities, topographic features, and chemosynthetic and nonchemosynthetic communities) and nonmobile benthic species that would be expected to spend their entire life cycle in the CPA were likely not affected to any discernible degree by the *Deepwater Horizon* explosion, oil spill, and response, based on the best available information, including recent sampling data. Similarly to the analysis of physical resources in the CPA described in the preceding paragraph, although unable to speculate as to the results of ongoing NRDA studies, BOEM has determined that the incomplete or unavailable information regarding nonmobile biological resources is not essential to a reasoned choice among alternatives because BOEM utilizes the best available scientifically credible information in its decisionmaking process.
- *Mobile Biological Resources within or Migrating through the CPA*: Certain mobile biological resources (i.e., birds, fish, marine mammals, and sea turtles) having ranges and/or habitats that may include different areas in the GOM may have individually been affected by exposure to oil and/or spill-response activities, provided they were in the vicinity of the *Deepwater Horizon* explosion, oil spill, and response during spill conditions. Precise information on the impacts on mobile biological resources within or migrating through the CPA is therefore not known, and it is not expected that these data would become publicly available within the timeline contemplated in the NEPA analysis of this Supplemental EIS. Although unable to speculate as to the results of ongoing NRDA studies, BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among the alternatives because the adverse impacts from routine activities associated with a CPA proposed action are expected to be small, even in light of how baseline conditions may have been changed by the *Deepwater Horizon* explosion, oil spill, and response. Moreover, based on the scientifically credible information that was available and applied in **Chapter 4.1.1**, such as peer-reviewed journals and government reports,

this incomplete or unavailable information is not essential to a reasoned choice among the alternatives because the subject-matter experts for this Supplemental EIS have already evaluated the probability and severity of these potential impacts and because this incomplete or unavailable information is not essential to understand every particular mechanism by which these significant impacts could occur. With regard to future potentially low-probability catastrophic spills, any incomplete or unavailable information regarding the nature of a very large spill would not be essential to a reasoned choice among the alternatives. This is because a catastrophic spill and its impacts are not "expected" as a result of a CPA proposed action since such a spill remains a low-probability event, particularly in light of improved safety and oil-spill-response requirements that have been put in place since the spill.

- *Endangered and Threatened Species*: BOEM reinitiated consultation with NMFS and FWS in light of new information that may become available on these species and in light of effects from the *Deepwater Horizon* explosion, oil spill, and response. Pending the completion of the reinitiated ESA section 7 consultation, BOEM has prepared an ESA section 7(d) determination (50 CFR § 402.09). Section 7(d) of the ESA requires that, after initiation or reinitiation of consultation under section 7(a)(2), the Federal agency "shall not make any irreversible or irretrievable commitment of resources with respect to the agency action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternative measures which would not violate" section 7(a)(2). BOEM has determined that a CPA proposed action during the reinitiated section 7 consultation period is consistent with the requirements of ESA section 7(d) because (1) approving and/or conducting a proposed CPA lease sale will not foreclose the formulation or implementation of any Reasonable and Prudent Alternative measures that may be necessary to avoid jeopardy (or the likely destruction or adverse modification of critical habitat) and (2) the Secretary of the Interior retains the discretion under OCSLA to deny, suspend, or rescind plans and permits authorized under OCSLA at any time, as necessary to avoid jeopardy. Lease sales alone do not constitute an irreversible and irretrievable commitment of resources. In addition, the results of consultation and any additional relevant information on endangered and threatened species can be employed during postlease activities to ensure that Reasonable and Prudent Alternative measures are not foreclosed. BOEM and BSEE have developed an interim coordination program with NMFS and FWS for individual consultations on postlease activities requiring permits or plan approvals while formal consultation and development of a new Biological Opinion is ongoing.

- *Natural Resource Damage Assessment (NRDA) Data*: In response to the *Deepwater Horizon* explosion, oil spill, and response, a major NRDA is underway to assess impacts to all natural resources in the GOM that may have been impacted by the resulting spill from the *Macondo* well, as well as impacts from the spill-response operations. The NRDA is mandated by the Oil Pollution Act of 1990. The U.S. Department of the Interior is a co-Trustee in the NRDA process, and BOEM is a cooperating agency on a Programmatic EIS being prepared as part of the NEPA analysis for NRDA. However, the NRDA process is being led by the NRDA Trustees, which include NOAA and DOI (FWS and NPS), but not BOEM. BOEM is listed as an affected party for NRDA purposes. At this time, limited data compiled in the NRDA process have been made publicly available. Because limited data have been made publicly available, most NRDA datasets are not available for BOEM to use in its NEPA analyses. BOEM acknowledges that the ability to obtain and use the NRDA data in its NEPA analyses could be relevant to reasonably foreseeable significant adverse impacts; however, the NRDA data are not essential to a reasoned choice among the alternatives. Impacts identified through the NRDA process would likely be the same under any alternative and obtaining these data would not help inform the decisionmaker on a reasoned choice among those alternatives. This is because, as discussed above, the adverse impacts associated with a proposed CPA lease sale are small, even in light of how baseline conditions in the CPA may have been changed by the *Deepwater Horizon* explosion, oil spill, and response. The impacts are expected to be small because of BOEM's lease sale stipulations and mitigating measures, site-specific mitigations that become conditions of plan or permit approval at the postlease stage, and mitigations required by other State and Federal agencies. Even if the NRDA data were essential to a reasoned choice among the alternatives, it is not publicly available and much of the data may not become available for many years. The NEPA allows for decisions to be made based on available scientifically credible information (peer-reviewed journals and studies, government reports, etc.) applied using accepted methodologies where the incomplete information cannot be obtained or the cost of obtaining is exorbitant. The NRDA process is ongoing and there is no timeline on when this information will be released. It is not within BOEM's authority to obtain this information. Cost is not an issue in obtaining the information, regardless of whether the cost would be exorbitant or not. Instead, the limitations on the NRDA process, including statutory requirements under the Oil Pollution Act of 1990, are the determining factors on the availability of this information. In light of the fact that the NRDA data may not be available for years, BOEM has used accepted scientific methodologies to evaluate each resource, as described in this chapter. Since the spill, BOEM's Gulf of Mexico OCS Region's Environmental Studies Program has continually modified its Studies Plan to reflect the Agency's current information needs for studies that address impacts and recovery from the oil spill. The scientific studies conducted by the Environmental Studies Program provide some of the data that BOEM relies on in making decisions in this Supplemental EIS. BOEM's proposed studies attempt to avoid duplication of study efforts while striving to fill information gaps where NRDA studies may not address particular resources and their impacts from the oil spill.

- *Socioeconomic and Cultural Resources*: Incomplete or unavailable information related to socioeconomic and cultural impacts (i.e., commercial and recreational fishing, recreational resources, archaeological resources, land use and coastal infrastructure, demographics, economic factors, and environmental justice) may be relevant to reasonably foreseeable adverse impacts on these resources. Although unable to speculate as to the results of ongoing NRDA studies, BOEM has determined that the incomplete or unavailable information would not be essential to a reasoned choice among alternatives because BOEM utilizes the best available scientifically credible information in its decisionmaking process.

This chapter has thoroughly examined the existing credible scientific evidence that is relevant to evaluating the reasonably foreseeable significant adverse impacts of the CPA proposed lease sales on the human environment. The subject-matter experts that prepared this Supplemental EIS conducted a diligent search for pertinent new information, and BOEM's evaluation of such impacts is based upon theoretical approaches or research methods generally accepted in the scientific community. All reasonably foreseeable impacts were considered, including impacts that could have catastrophic consequences, even if their probability of occurrence is low (**Appendix B**). Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it is essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether generally accepted scientific methodologies can be applied in its place (40 CFR § 1502.22).

4.1.1. Alternative A—The Proposed Action

4.1.1.1. Air Quality

BOEM has reexamined the analysis for air quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for air quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of air quality and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.1 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

As BOEM has previously noted in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, and despite the new information identified and provided below, there is incomplete or unavailable information regarding air quality and potential air impacts. Although final summary information and reports on air quality impacts from the *Deepwater Horizon* explosion, oil spill, and response may be forthcoming, USEPA, NOAA, and other agencies obtained and released to the public a large number of air quality measurements indicating that air impacts tended to be minor and below USEPA's health-based standards. As there are no continuing sources of air pollution related to the *Deepwater Horizon* explosion, oil spill, and response, BOEM would not expect any additional measurements or information to alter the conclusions from currently existing data. In addition, as noted below and in **Appendix A**, there are a number of competing methods and available models for estimating and tracking potential air emissions and impacts. Each of these methods and models has inherent limitations, particularly with regard to the offshore environment in which a CPA proposed action would take place. In acknowledgement of these limitations, BOEM's subject-matter experts, using their best professional judgment and experience, have developed conservative assumptions and modeling parameters so as to ensure that the impact conclusions herein are reasonable and not underestimated. As such, although there is incomplete or unavailable information on air quality impacts at this time that may be relevant to reasonably foreseeable adverse impacts, this information is not essential to a reasoned choice among alternatives. Emissions of pollutants into the atmosphere from the routine activities associated with a CPA 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. The impacts of the OCS emissions on the onshore air quality are below BOEM's Significance Levels and the NAAQS. The USEPA commented that BOEM should compare model results with the USEPA's significant impact levels (SIL's). Therefore, the modeled results were compared with the U.S. Environmental Protection Agency's SIL's. The modeled concentrations for annual nitrogen dioxide (NO_2) (0.4 $\mu g/m^3$) and 24-hour particulate matter of 2.5 microns or less ($PM_{2.5}$) (0.3 $\mu g/m^3$) in the Class I area exceeds the U.S. Environmental Protection Agency's SIL's for annual NO_2 (0.1 $\mu g/m^3$) and 24-hour $PM_{2.5}$ (0.07 $\mu g/m^3$) in the Class I area. Although the U.S. Environmental Protection Agency's SIL's were exceeded, BOEM expects in practice, if the emissions were distributed more realistically across the CPA, that emissions would not exceed the U.S. Environmental Protection Agency's SIL's. The modeling that was conducted was overly conservative. All of the emissions during 1 year for the entire CPA, which would actually be dispersed throughout the CPA, were modeled as if they originated in Mississippi Canyon Block 856.

While regulations are in place to reduce the risk of impacts from hydrogen sulfide (H_2S) and while no H_2S-related deaths have occurred on the OCS, accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. These emissions from routine activities and accidental events associated with a CPA proposed action are not expected to have concentrations that would change onshore air quality classifications.Air Quality Modeling

There are many factors that BOEM evaluates to determine the potential impact occurring from offshore air emissions. These include estimates for likely emission sources, likely emission locations, emission rates, timeframes, and the likelihood of transport by wind resulting in contact to specified environmental features. Sensitivity of the environmental resources and potential effects are addressed in the analyses for the specific resources of concern (**Chapter 4.1.1**). BOEM uses data gathered during recent OCS emission inventories, along with a scenario or estimates of future production, to evaluate the potential effects of emissions. The scenario provides (1) the set of assumptions for and estimates of future activities, (2) the rationale for the scenario assumptions and estimates, and (3) the type, frequency, and quantity of emissions from offshore sources associated with a CPA proposed action.

BOEM determined projected emissions resulting from the activities on the lease based on known emissions from various equipment, such as diesel engines and generators, and the level of offshore activity projected in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. BOEM then uses a numerical model to calculate the concentration of five pollutants (NO_2, sulphur dioxide [SO_2], particulate matter less than or equal to 2.5 μm [$PM_{2.5}$], particulate matter less than or equal to 10 μm [PM_{10}], and carbon monoxide [CO]) at the receptor. Inputs to the model include the location of the emission source and the receptors, the aforementioned emissions, source parameters such as source height and source stack gas temperature, and a 5-year history of meteorological conditions. The latter two parameters influence the dispersion of the pollutant as it is carried from the source to the receptor. The model output is the concentration of the pollutant at the onshore receptor location at specified time intervals. A description of the numerical model, called the Offshore Coastal Dispersion (OCD) Model, and its results are summarized in **Appendix A**.

OCD Model

The OCD modeling was performed for the CPA Class I and Class II Areas, with the hypothetical CPA source located at Mississippi Canyon Block 856, which is approximately 56 mi (90 km) from shore. Meteorological data used were from the period 2000 through 2004. The surface data came from Patterson, Louisiana, and upper air data came from Slidell, Louisiana. Buoy data for Mississippi Canyon Block 856 caome from Buoy 42040. These meteorological data points are the closest, physically, to the proposed lease sale area available to BOEM and, therefore, are the best approximation available. BOEM calculated scenario-specific emissions based on the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) and Rigzone (2009). A spreadsheet was developed based on the findings of this study (Billings et al., official communication, 2012). To provide a conservative estimate, BOEM assumed a high-range of activity emissions during the year with the greatest amount of activity (e.g., drilling and platform and pipeline installation) out of the 40-year analysis period for a CPA proposed action. All of the scenario-predicted emissions were then modeled at one location in the CPA. Even with all the emissions being attributed to a single point (which would not be the case in reality and thus provides a conservative estimate of impacts), the CPA emissions are projected to have minimal impacts to onshore air quality. The CPA emissions are within BOEM's maximum allowable increase for the scenario. Methodology, emissions, and modeling results are discussed further in **Appendix A**. As shown in **Appendix A**, emissions of pollutants into the atmosphere from the activities associated with the OCS Program are estimated to have minimal effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and mixing heights, and the resulting pollutant concentrations. Given that these very conservative estimates of emissions were modeled and still below both agencies' regulatory thresholds, BOEM believes that the potential onshore impacts related to emissions from OCS oil and gas activities that may result from a CPA proposed action will not be significant.

BOEM is in the process of a comprehensive assessment of numerical methods (including variety of sensitivity analysis, comparison of emission inventories and evaluation of emission scenarios) using USEPA-approved models, which will help us to support our scientific statements in future EIS's. This modeling assessment will be helpful when considering that modern air quality models are still in development and need to be evaluated before they are widely used for realistic estimations of pollutant concentrations over offshore and coastal environments. However, this assessment will take time, potentially years, and there will always be some limitations in the application of models. For this reason, BOEM is using the OCD Model as it is appropriate for the offshore environment. BOEM's subject-matter experts also used their professional judgment in developing and modeling parameters to ensure that the results were conservative.

On the basis of OCD modeling for NO_x, SO_x, $PM_{2.5}$, PM_{10}, and CO, and the *Gulf of Mexico Air Quality Study* for O_3 (Systems Applications International et al., 1995), BOEM is confident that offshore OCS oil and gas activities associated with a CPA proposed action will not contribute to exceedances of the NAAQS at the shoreline. The inference of conclusions from this study remains appropriate given both the decrease in the number of wells drilled and wells producing from wells in water depths <1,000 ft (305 m) and the industrial expansions into the deepwater Gulf of Mexico. During the past 5 years (2008-2012), the number of wells drilled in shallow water (<1,000-m [305-m] water depth) decreased by 45 percent from 468 wells in 2008 to 256 wells in 2012. The number of wells producing decreased by 23 percent from 5,648 to 4,355 wells during the same 5-year timeframe. Simultaneously, production expansion into deep water is documented in *Deepwater Gulf of Mexico 2009: America's Expanding Frontier* (USDOI, MMS, 2009a) and in the preceding biennial reports. Over the last 22 years, there has been an overall expansion in all phases of deepwater activity. There are approximately 5,700 active leases in the Gulf of Mexico OCS, 60 percent of which are in deep water (USDOI, BOEM, 2014a). (Note that lease status may change daily; therefore, the current number of existing leases is an approximation.) Contrast this to the approximately 5,600 existing Gulf of Mexico leases in 1992, only 27 percent of which were in deep water. On average, there are 26 rigs drilling in deep water in 2014, compared with only 3 rigs in 1992 (USDOI, BOEM, 2014b). This trend is observable in seismic activity, leasing, exploratory drilling, field discoveries, and production. With movement of the bulk of activities to deep water, air emission-producing sources are moving farther from shore. This further reduces the potential for air quality impacts to onshore from a proposed CPA lease sale. Because the bulk of activities from a proposed CPA lease sale would be expected to follow this trend, they would be even further removed from impacting the shoreline.

The quantity of air pollutants emitted is the direct result of the level of offshore activity. The concentrations of the emissions at the shoreline are influenced by the distance between the source of the emissions and the receptors. With the simultaneous decrease in both the number of wells drilled and the number of wells producing in water depths <1,000 m (305 m) (shallow waters closest to shore) and the increase is leases, drilling, and production in water depths >1,000 m (305 m) (deeper waters farther from shore), it can be assumed that the emissions related to exploration and production activity have also moved farther offshore. As a result of these trends for fewer wells and wells that are farther offshore, the OCD modeling results obtained from Systems Applications International et al. (1995), which demonstrate no NAAQS exceedances, remain conservative and are still applicable to the discussion of shoreline impacts from lease and associated activity projected to result from proposed CPA Lease Sales 235, 241, and 247. BOEM, however, supplemented this knowledge with additional data available since that time and by running the OCD model accompanying this Supplemental EIS. Emissions from proposed action activities as modeled in **Appendix A** will not significantly contribute to any onshore exceedances of a significant impact to onshore NAAQS.

One of the limitations of the OCD model is that it is unable to directly model contributions to ambient ozone (O_3), as ozone is formed in the ambient atmosphere from precursor pollutants. To address this limitation, BOEM examined available studies on OCS oil and gas activities' contribution to onshore ozone levels, as described below and in **Appendix A**. These studies confirm that OCS oil and gas activities are likely to only have a minimal impact on onshore ozone.

Ozone Model

The Comprehensive Air Quality Model with extensions (CAMx) was used to model contribution during an August 2000 ozone episode (Yarwood et al., 2004). The OCS contributions to ozone exceedances were minor. Yarwood et al. (2004) used a photochemical model to analyze the Year 2000 Gulfwide Emissions Inventory (GWEI) and selected the Houston-Galveston-Brazoria nonattainment area since it has the most severe ozone problem in the Gulf of Mexico region (System Applications International et al., 1995). One of the main relevant findings in Yarwood et al. (2004) is as follows: "The average impact of the Year 2000 GWEI emissions on 8-hour ozone levels above 85 ppb in Houston area is 0.2 ppb; although larger impacts may occur over the Gulf of Mexico." Haney et al. (2008) performed a modeling investigation using the Year 2000 and Year 2005 GWEI's in the WPA and CPA to evaluate the impact of offshore emissions on offshore and onshore ozone air quality, in which they proposed an emission-reduction scenario. They found a particular ozone episode where the onshore impact from all offshore oil-and-gas-related sources was small but generally larger than those estimates using the Year 2000 GWEI. They noticed higher simulated ozone concentrations from 2005 emissions due to increases in NO_x and VOC concentrations.

Greenhouse Gas Emissions

In response to the FY 2008 Consolidated Appropriations Act, USEPA issued 40 CFR part 98, which requires reporting of greenhouse gas emissions, such as carbon dioxide (CO_2). Subpart W of the Greenhouse Gas Reporting Rule requires petroleum and natural gas facilities that emit 25,000 metric tons or more of CO_2 equivalents per year to report emissions from equipment leaks and venting. On average, the amount of CO_2 emissions from a typical well site during operations is about 237-439 tons per year. Subpart C of the Green House Gas Reporting Rule requires operators to report greenhouse gas emissions from general stationary fuel combustion sources to USEPA. At this point, this is just a reporting requirement; there are no specific NAAQS or emission limitations for greenhouse gases.

BOEM has included in **Appendix A** modeled estimates for certain greenhouse gases that may be directly emitted during OCS oil and gas activities. At this time, the greenhouse gas emissions related to OCS oil and gas activities are a very small percentage of national emissions, and it would be impossible to tease out the impacts from this small incremental addition from global climate change impacts attributable to all other global sources. As such, BOEM does not believe that the potential greenhouse gas emissions directly attributable to oil and gas activities on the OCS as a result of a CPA proposed action are significant to global greenhouse gas levels.

Impacts of Routine and Accidental Events

The following routine activities associated with a CPA proposed action 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 fugitive emissions. The impact analysis is based on four parameters—emission rates, surface winds, atmospheric stability, and the mixing height. A detailed impact analysis of the routine impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on air quality can be found in Chapter 4.2.1.1.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.1 of the WPA 233/CPA 231 Supplemental EIS. Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimal effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and mixing heights, and the resulting pollutant concentrations.

The accidental release of hydrocarbons related to a CPA proposed action would result in the emission of air pollutants. The OCS oil- and gas-related accidents could include the release of oil, condensate, or natural gas or chemicals used offshore or pollutants from the burning of these products. The air pollutants include criteria NAAQS pollutants, volatile and semi-volatile organic compounds, H_2S, and methane. If a fire was associated with the accidental event, it would produce a broad array of pollutants, including all NAAQS-regulated primary pollutants, including NO_2, CO, SO_2, VOC, PM_{10}, and $PM_{2.5}$. Response activities that could impact air quality include in-situ burning, the use of flares to burn gas and oil, and the use of dispersants applied from aircraft. Measurements taken during an in-situ burning show that a major portion of compounds was consumed in the burn; therefore, pollutant concentrations would be expected to be within the NAAQS. These response activities are temporary in nature and occur offshore; therefore, there are little expected impacts from these actions to onshore air quality. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Regulations and NTL's include safeguards and protective measures, which are in place, to protect workers from H_2S releases. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Leases Sale 235, 241, and 247 on air quality can be found in Chapter 4.2.1.1.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.1 of the WPA 233/CPA 231 Supplemental EIS. Other emissions of pollutants into the atmosphere from accidental events as a result of a CPA 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.

Summary and Conclusion

BOEM has reexamined the analysis for air quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for air quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The OCD modeling results (included in **Appendix A**) confirms BOEM's conclusions in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS that offshore activities would not result in exceedances of the NAAQS at the shoreline. The only potential exception is for ozone, where there may be some minimal contribution to ozone at the shoreline. Ozone levels are on a declining trend because of air-pollution control measures that have been implemented by the States. This downward trend is expected to continue as a result of local as well as nationwide air-pollution control efforts.

Cumulative Impacts

Background/Introduction

An impact analysis for cumulative impacts in the CPA is described in this chapter. This cumulative analysis considers OCS oil- and gas-related and non-OCS oil- and gas-related activities that could occur and adversely affect onshore air quality from OCS sources during the 40-year analysis period.

The activities in the cumulative scenario that could potentially impact onshore air quality include a CPA proposed action and the OCS Program, State oil and gas programs, other major offshore but non-OCS oil- and gas-related factors influencing the offshore environments (such as sand borrowing and transportation), onshore non-OCS oil- and gas-related activities such as emissions from industry and mobile sources (cars/trucks) related to human activities, onshore non-OCS oil- and gas-related sources unrelated to human activities (such as forest fires), accidental releases such as oil spills, accidental releases of hydrogen sulfide, natural events (e.g., hurricanes), and catastrophic oil spills.

Emissions contributing to air quality degradation come from many sources. The NAAQS include ozone, particulate matter, nitrous dioxide, carbon monoxide, and sulfur dioxide. Air pollutants on the NAAQS list are commonly referred to as criteria pollutants. Although these pollutants can all occur naturally, elevated levels are often the result of anthropogenic activities.

Ozone pollution is mainly a daytime phenomenon, occurring during the summer months. The concentration of ozone in the air is determined not only by the amounts of ozone precursor chemicals but also by weather and climate factors. Strong sunlight, warm temperatures, stagnant high-pressure weather systems, and low wind speeds cause ground-level ozone to form and accumulate in harmful concentration in the air. Ozone is not emitted directly into the air. Ozone is a secondary pollutant formed in the presence of sunlight from the reaction of volatile organic compounds (VOC's) and NO_2. Most emissions sources of ozone precursor pollutants (NO_2, and VOC) are onshore. Emissions sources of ozone precursor pollutants include the following: vehicles such as automobiles, trucks, buses, aircraft, and locomotives; construction equipment; lawn and garden equipment; sources that combust fuel, such as large industries and utilities; small industries such as gas stations and print shops; and consumer products, including some paints and cleaners. In addition, biogenic, or natural emissions from trees and plants, are a major source of VOC's. According to the USEPA, automobiles and other mobile sources contribute about one-half of the NO_x that is emitted. According to NOAA, power plants emit about one-quarter of the total U.S. human-made contribution of NO_x to the atmosphere. All other sources of NO_x emissions account for one-quarter of the United States' totals. The total impact from the combined onshore and offshore emissions would be significant to the ozone nonattainment areas in southeast Texas and the parishes near Baton Rouge, Louisiana.

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas-related impacts include the drilling of exploration, delineation, and development wells; platform installation; and service-vessel trips, flaring, and fugitive emissions. Routine oil spills are also possible. Emission trends from Gulfwide platform sources from 2000, 2005, 2008, and 2011 show that emissions offshore show little variance across sampling intervals. Emissions of pollutants into the atmosphere from activities associated with the OCS Program 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 OCS activities are estimated to be within Prevention of Significant Deterioration (PSD) Class II allowable increments. The modeling results indicate that the cumulative impacts to a PSD Class I Area are well within the PSD Class I allowable increment (Wheeler et al., 2008).

Portions of the Gulf Coast have ozone levels that exceed the Federal air quality standard. Ozone levels are on a declining trend because of air-pollution control measures that have been implemented by the Gulf Coast States. This downward trend is expected to continue as a result of local as well as nationwide air-pollution control efforts. However, a more stringent air quality standard has recently been implemented by USEPA, which may result in increasing the number of parishes/counties in the coastal states in violation of the Federal ozone standard. There is also a proposal to further decrease the ozone standard. If the ozone standard was lowered, although OCS emissions from a CPA proposed action would not vary, the OCS emissions in those newly designated areas would have an incrementally larger contribution to the onshore ozone levels. Although air quality is improving, the number of areas in nonattainment could increase due to more stringent standards (USEPA, 2010).

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 (USEPA, 2013b). The Gulf Coast visibility is expected to improve somewhat as a result of regional and national programs to reduce emissions. However, the incremental contribution from a CPA proposed action would be very small and would have an insignificant effect on ozone levels in onshore ozone nonattainment areas. This minimal impact would not be a contributing factor to the States' schedule for attainment. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A spill could result in the loss of crude oil, crude oil with a mixture of natural gas, or refined fuel. Air quality could be affected by the additional response vessel traffic, volatilization of components of the oil, and natural gas if released. Impacts from individual spills would be localized and temporary.

The safety issues related to an accidental release of hydrogen sulfide include the following: irritation, injury, and lethality from leaks; exposure to sulfur oxides produced by flaring; equipment and pipeline corrosion; and outgassing and volatilization from spilled oil.

In the event of a low-probability catastrophic spill, though not reasonably foreseeable and not part of a CPA proposed action, oil may be burned to prevent it from entering sensitive habitats. The USEPA released two peer-reviewed reports concerning dioxins emitted during the controlled burns of oil during the *Deepwater Horizon* explosion, oil spill, and response (Aurell and Gullett, 2010; Schaum et al., 2010). Dioxins is a category that describes a group of hundreds of potentially cancer-causing chemicals that can be formed during combustion or burning. The reports found that, while small amounts of dioxins were created by the burns, the levels that workers and residents would have been exposed to were below USEPA's levels of concern. For more information on the potential impacts of a low-probability catastrophic event, refer to **Appendix B.3.1.1**.

The incremental contribution of a CPA proposed action to the cumulative impacts would be minimal. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a CPA proposed action would be very small. The cumulative contribution to visibility impairment from a CPA proposed action is also expected to be very small. Area visibility is expected to improve somewhat as a result of regional and national programs to reduce emissions. A CPA proposed action would have an insignificant effect on ozone levels in ozone nonattainment areas and would not interfere with the States' schedule for compliance with the NAAQS. A routine OCS oil- and gas-related spill is not likely to impact onshore air quality because of the distance to shore. However, it would be possible for a spill from an OCS pipeline rupture to occur in State waters. Such a spill would have the potential to impact onshore air quality. Pipelines are built with safety devices to minimize pipeline spills. Because of the distance between an offshore low-probability catastrophic spill and the shore, it is unlikely that a low-probability catastrophic spill, should it occur, could adversely impact onshore air quality.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS oil- and gas-related activities that generate criteria pollutants include industrial activities in territorial seas and coastal waters, industrial and transportation activities that occur onshore, and naturally occurring events onshore such as forest fires. Hurricanes are natural events that can cause emissions when they cause structural damage that result in oil spills or gas releases. Further air emissions are generated by the additional traffic from response vessels, uncontrolled or controlled burns, and ultimately, new repairs and construction to pipelines or platforms.

State oil and gas programs onshore, in territorial seas, and in coastal waters also generate emissions that affect onshore air quality. These emissions are regulated by State agencies and/or USEPA. Reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts, and as a result, constitute minor impacts to onshore air quality.

Major onshore emission sources from non-OCS oil- and gas-related activities include power generation, industrial processing, manufacturing, refineries, commercial and home heating, naturally occurring forest fires, and motor vehicles. One other NAAQS pollutant, lead, is not associated with offshore oil and gas activity so it is not discussed below as cumulative impacts relative to a CPA proposed action and are not useful for purposes of NEPA.

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 (USEPA, 2013b).

A spill such as from State oil and gas activity or from a tanker carrying imported oil could result in the loss of crude oil, crude oil with a mixture of natural gas, or refined fuel. Air quality would be affected by the additional response vessel traffic, volatilization of components of the oil, and natural gas if released. Impacts from individual spills would tend to be localized and temporary.

The safety issue related to an accidental release of hydrogen sulfide is described in **Chapter 3.1.1.9**. The same safety precautions and regulations described for a CPA proposed action are applicable to the non-OCS oil- and gas-related scenario. That is, a typical safety zone is usually established in an area with the concentration of hydrogen sulfide greater than 20 parts per million (ppm) from the source or a platform.

The effects of hurricanes on the offshore infrastructure are described in **Chapter 3.3.5** of this Supplemental EIS, Chapter 3.3.5.2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 3.3.5 of the WPA 233/CPA 231 Supplemental EIS. Hurricanes mainly cause damage to offshore infrastructures and pipelines, which may result in an oil spill. For the cumulative scenario, hurricanes could also damage non-OCS oil- and gas-related infrastructure such as platforms and pipelines in State waters. Any emissions from non-OCS oil-spill and response activities that occur in State territorial seas or waters are expected to be the same as a CPA proposed action and to have minimum effects on onshore air quality.

Most emissions sources of ozone precursor pollutants (NO_2, and VOC) are onshore. Emissions sources of ozone precursor pollutants include the following: vehicles such as automobiles, trucks, buses, aircraft, and locomotives; construction equipment; lawn and garden equipment; sources that combust fuel, such as large industries and utilities; small industries such as gas stations and print shops; and consumer products, including some paints and cleaners. In addition, biogenic, or natural emissions from trees and plants, are a major source of VOC's. According to USEPA, automobiles and other mobile sources contribute about half of the NO_x that is emitted. According to NOAA, power plants emit about one-quarter of the total U.S. human-made contribution of NO_x to the atmosphere. All other sources of NO_x emissions, combined, account for one-quarter of the United States' totals.

Shore-based sources of $PM_{2.5}$ include all types of combustion activities related to both human activities and naturally occurring sources. Sources range from large and highly regulated industrial sources down to sources related to activities of an individual such as trash burning. Some of the most cited additional sources include fuel burning associated with motor vehicles, power plants, and wood burning, and certain industrial processes.

Fine particulate matter can also form when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes. Sources of coarse particles, PM_{10}, include crushing or grinding operations and dust from paved or unpaved roads.

Sources of SOx include all types of activities ranging from large, highly regulated industrial sources, down to sources related to individual human activities such as outdoor grilling. Fossil fuels contain varying amounts of sulfur. Over 65 percent of the SO_x released to the air is attributable to electric utilities that burn coal. Some additional commonly cited sources of SO_x include pulp and paper mills, petroleum refining, and nonferrous smelters. Fuel burning associated with motor vehicle usage is another source.

Sources of NO_x include all types of activities ranging from large, highly regulated industrial sources down to sources related to the activities of individual people, for example, the use of personal water craft (e.g., jet skis). Some of the most common anthropogenic sources of NO_x include motor vehicles, electric utilities, and other industrial commercial and residential sources that burn fuels. Because NO_x is a highly reactive chemical, it can contribute to ozone formation in the presence of VOC's in the presence of heat and sunlight.

Sources of CO include all types of activities ranging from large, highly regulated industrial sources, down to sources related to individual human activities such as tobacco smoke and using gasoline-powered equipment or generators. Some of the most common CO sources include residential sources that burn fuel and motor vehicles. According to USEPA, motor vehicles account for up to 90 percent of the CO emissions in urban areas.

Other major factors influencing coastal environments, such as sand borrowing and transportation in State territorial waters, also generate emissions that can affect air quality. These emissions are regulated by State agencies and/or USEPA. Reductions have been achieved through the use of low sulfur fuels and catalytic reduction and other efforts, and as a result, constitute minor impacts to onshore air quality.

Summary and Conclusion

BOEM has reexamined the analysis for air quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above.

Emissions of pollutants into the atmosphere from activities associated with the OCS Program 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. Ozone precursors, NO_x and VOC's, are shown to have more ozone-emitting sources present onshore. Onshore impacts on air quality from emissions from OCS activities are estimated to be within PSD Class II allowable increments. The modeling results indicate that the cumulative impacts to a PSD Class I Area are well within the PSD Class I allowable increment.

Ozone levels are on a declining trend because of air-pollution control measures that have been implemented by the 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.

Based on the discussion above and modeled impacts in **Appendix A**, the incremental contribution of a CPA proposed action to the cumulative impacts is not significant. The incremental contribution of a CPA proposed action to the cumulative impacts would likewise not significantly affect coastal nonattainment areas. The cumulative contribution to visibility impairment from a CPA proposed action would also not be significant.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of State and Federal databases, including updates to regulations, was conducted to determine the availability of recent information. It has been discovered that Birmingham, Alabama, is no longer in nonattainment for any NAAQS criteria pollutant.

BOEM calculated scenario-specific emissions based on the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) and Rigzone (2009). Likewise, BOEM conducted OCD modeling on activity that will result from a lease sale using the scenarios for OCS activities in the CPA. These results are presented in **Table A-1** (**Appendix A**). The modeled impacts are below BOEM's maximum allowable increases, NAAQS, and the U.S. Environmental Protection Agency's SIL's for all the criteria pollutants except for the annual NO_x and the 24-hour $PM_{2.5}$ for PSD Class I areas. Although the SIL's were exceeded, BOEM expects in practice, if the emissions were distributed more realistically across the CPA, that emissions would not exceed the SIL; and thus, actual emissions likely to result from a CPA proposed action would likely not be significant. The modeling that was conducted was overly conservative. All the emissions during 1 year for the entire CPA, which would actually be dispersed throughout the CPA, were modeled as if they originated in Mississippi Canyon Block 856.

Although final summary information and reports on air quality impacts from the *Deepwater Horizon* explosion, oil spill, and response may be forthcoming, USEPA, NOAA, and other agencies obtained and released to the public a large number of air quality measurements indicating that air impacts tended to be minor and below USEPA's health-based standards. As there are no continuing sources of air pollution related to the *Deepwater Horizon* explosion, oil spill, and response, BOEM would not expect any additional measurements or information to alter the conclusions from currently existing data. As such, although there is incomplete or unavailable information on air quality impacts at this time that may be relevant to reasonably foreseeable adverse impacts, this information is not essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

4.1.1.2. Water Quality

4.1.1.2.1. Coastal Waters

BOEM has reexamined the analysis for coastal water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for coastal water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of water quality and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.2 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since those documents were published is presented below.

A detailed description of coastal waters can be found in Chapter 4.2.1.2.1 of the 2012-2017 WPA/CPA Multisale EIS.

Impacts of Routine and Accidental Events

The routine activities associated with a CPA proposed action 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; maintenance dredging of existing navigational canals; service-vessel discharges; and nonpoint-source runoff from platforms and OCS Program-related vessels. 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. These activities are not only highly regulated but also localized and temporary in nature. The impacts to coastal water quality from routine activities associated with a CPA proposed action should be minimal because of the distance to shore of most routine activities, USEPA and USCG regulations that restrict discharges, and few, if any, new pipeline landfalls or onshore facilities would be constructed. A detailed impact analysis of the routine impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on coastal waters can be found in Chapter 4.2.1.2.1.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information can be found in Chapter 4.2.1.2.1 of the WPA 233/CPA 231 Supplemental EIS.

Accidental events associated with a CPA proposed action that could impact coastal water quality include spills of oil and refined hydrocarbons, releases of natural gas, usage of chemical dispersants in oil spill response, spills of chemicals or drilling fluids, loss of well control, collisions, or other malfunctions that would result in such spills. Accidental events associated with a CPA proposed action that could impact coastal water quality include spills of oil and refined hydrocarbons, releases of natural gas and condensate, usage of chemical dispersants in oil-spill response, and spills of chemicals or drilling fluids. The loss of well control, pipeline failures, collisions, or other malfunctions could result in such spills. Although response efforts may decrease the amount of oil in the environment, the response efforts may also impact the environment through, for example, increased vessel traffic, hydromodification, and the application of dispersants. In addition to response efforts, natural processes can physically, chemically, and biologically degrade oil over time. For coastal spills, two additional factors that must be considered are the shallowness of the area and the proximity of the spill to shore. Chemicals used in the oil and gas industry are not a significant risk in the event of a spill because they are either nontoxic, are used in minor quantities, or are only used on a noncontinuous basis. Spills from collisions are not expected to be significant because collisions occur infrequently. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on coastal waters can be found in Chapter 4.2.1.2.1.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information can be found in Chapter 4.2.1.2.1 of the WPA 233/CPA 231 Supplemental EIS. Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B** of this Supplemental EIS.

Summary and Conclusion

BOEM has reexamined the analysis for coastal water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for coastal water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, as these newly available studies confirmed earlier estimates of hydrocarbon releases and noted the overall return of pre-spill polycyclic aromatic hydrocarbon (PAH) concentrations thus far. Dispersant studies continue to illustrate the ongoing debate on the use of dispersant as a remediation tool. Regulations relevant to the quality of offshore waters continue to be implemented and updated to more stringent standards. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

Activities in the cumulative scenario that could impact coastal water quality generally include the broad categories of a CPA proposed action and the OCS Program, alternative energy activities, alternate use programs for platforms, sand borrowing, State oil and gas activity, the activities of other Federal agencies (including the military), natural events or processes, and activities related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). Many of these categories would cause some of the same specific impacts (e.g., vessel traffic would occur for all of those categories except natural processes).

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas-related impacts include erosion and runoff, sediment disturbance and turbidity, vessel discharges, and accidental releases of oil, gas, or chemicals. Further discussion of these impacts is presented below.

Erosion and runoff from nonpoint sources degrade water quality. Nonpoint-source runoff from onshore support facilities could result from OCS oil- and gas-related activities; however, as discussed below, OCS activities are not the leading source of contaminants that impair coastal water quality. The leading source of contaminants that impair coastal water quality is urban runoff.

Sediment disturbance and turbidity may result from nearshore pipeline installation, maintenance dredging, and disposal of dredge materials. These impacts generally degrade water quality locally and are not expected to last for long periods of time.

Since the marine environment is a dynamic system, sediment quality and water quality can affect each other. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., adsorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are (re)suspended (e.g., due to dredging or a storm event), the resuspension can lead to a temporary shift in water quality, including a localized and temporal release of any formally sorbed metals as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982). Additionally, sediment disturbances from storms, especially hurricanes, may also lead to any buried coastal oil being released, as was seen by the deposition of *Deepwater Horizon* tarballs on some beaches after Hurricane Isaac (Burdeau and Reeves, 2012; Overton, official communication, 2012).

Vessel discharges can degrade water quality. Vessels may be service vessels supporting a CPA proposed action or OCS oil- and gas-related activities. Fortunately, for many types of vessels, most discharges are treated or otherwise managed prior to release through regulations administered by USCG and/or USEPA, and many regulations are becoming more stringent. The USCG Ballast Water Management Program became mandatory for some vessels in 2004 (33 CFR part 151 subparts C and D) (USDHS, CG, 2012b). The goal of the program was designed to prevent the introduction of nonindigenous (invasive) species that would affect local water quality. The USCG is increasing its regulations on ballast water management by establishing a standard for the allowable concentration of living organisms in ballast water discharged from ships in waters of the U.S and by establishing an approval process for ballast water management systems. The final rule was published on March 23, 2012, in the *Federal Register* and became effective on June 21, 2012 (USDHS, CG, 2012b). The final Vessel General Permit (VGP), which was issued by USEPA, became effective on December 19, 2008, and was an addition to already existing NPDES permit requirements. The permit strengthened the NPDES regulations so that discharges incidental to the normal operation of vessels operating as a means of transportation were no longer excluded unless exempted by Congressional legislation. On March 28, 2013, USEPA reissued the VGP for another 5 years (USEPA, 2013a). The reissued permit, the 2013 VGP, superseded the 2008 VGP on December 19, 2013. The 2013 VGP continues to regulate 26 specific discharge categories that were contained in the 2008 VGP and is more stringent because the permit contains numeric ballast water discharge limits for most vessels and more stringent effluent limits for oil-to-sea interfaces and exhaust gas scrubber washwater (USEPA, 2013c). The draft Small Vessel General Permit (sVGP), once finalized, will authorize discharges incidental to the normal operation of nonmilitary and nonrecreational vessels less than 79 ft (24 m) in length (USEPA, 2011a). These regulations should minimize the cumulative impacts of vessel activities.

Accidental releases of oil, gas, or chemicals would degrade water quality during and after the spill until either the spill is cleaned up or natural processes degrade or disperse the spill. These accidental releases could be a result of a CPA proposed action or ongoing OCS activity. The impacts of low-probability catastrophic spills, though not reasonably foreseeable and not part of a CPA proposed action, are discussed in **Appendix B**. A low-probability catastrophic event would not be expected to occur in coastal waters, but a low-probability catastrophic spill in offshore waters could affect coastal waters. For example, the oil spill resulting from the *Deepwater Horizon* explosion impacted coastal waters and sediments in Louisiana, Mississippi, Alabama, and Florida. The extent of impact from a spill depends on the release location and the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time (refer to Appendices A.2 and A.3 of the 2012-2017 WPA/CPA Multisale EIS). The effect on coastal water quality from spills estimated to occur from a CPA proposed action 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).

A major hurricane can affect OCS activities and result in a greater number of coastal oil and chemical spill events with increased spill volume and oil-spill-response times. In the case of an accidental event, it is likely that response efforts would reduce the amount of oil. **Chapter 3.2.1.9** of this Supplemental EIS and Chapter 3.2.1.9 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS provide further discussion of oil-spill-response considerations. Coastal water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, hydromodification (e.g., dredging, berm building, boom deployment), and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment.

Non-OCS Oil- and Gas-Related Impacts

Activities not related to a CPA proposed action or the OCS Program that may impact coastal waters include State oil and gas activities, alternative energy activities, alternate use programs for platforms, sand borrowing, the activities of other Federal agencies (including the military), natural events or processes, and activities related to the direct or indirect use of land and waterways by the human population. These activities may result in erosion and runoff, sediment disturbance and turbidity, vessel discharges, and accidental releases of oil, gas, or chemicals. Further discussion on these impacts is described below.

Water quality in coastal waters of the northern Gulf of Mexico is highly influenced by season. Seasonality influences salinity and dissolved oxygen, nutrient content, temperature, pH and Eh, pathogens, turbidity, metals, and organic compounds. Furthermore, as noted above, it is also important to consider sediment quality as sediment quality can affect water quality.

Erosion and runoff from nonpoint sources degrade water quality. Nonpoint-source runoff could result from State oil and gas activities and other industries and coastal development. The leading source of contaminants that impair coastal water quality is urban runoff. Urban runoff can include suspended solids, heavy metals and pesticides, oil and grease, nutrients, and organic matter. Urban runoff increases with population growth, and the Gulf Coast region has experienced a 109 percent population growth since 1970, with an additional expected 15 percent increase by 2020 (USDOC, NOAA, 2011a). The National Research Council (2003, Table I-4, page 237) estimated that, on average, approximately 26,324 bbl of oil per year entered Gulf waters from petrochemical and oil refinery industries in Louisiana and Texas. **Chapter 3.1.1.7** of this Supplemental EIS and Chapter 3.1.1.7 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS discuss the various sources of petroleum hydrocarbons that can enter the Gulf of Mexico in further detail. The natural emptying of rivers into the GOM as part of the water cycle may introduce chemical and physical factors that alter the condition of the natural water through both natural and anthropogenic sources, such as the addition of waterborne pollutants and inflowing waters of different temperature, as well as inputs to the GOM from groundwater discharge and precipitation. The Mississippi River introduced approximately 3,680,938 bbl of oil and grease per year from land-based sources (NRC, 2003, Table I-9, page 242) into the waters of the Gulf. Nutrients carried in waters of the Mississippi River contribute to seasonal formation of the hypoxic zone on the Louisiana-Texas shelf. The USEPA has regulatory programs designed to protect the waters that enter the Gulf, including the regulation of point-source discharges.

Sediment disturbance and turbidity may result from nearshore pipeline installation, maintenance dredging, disposal of dredge materials, sand borrowing, sediment deposition from rivers, and hurricanes. Turbidity is also influenced by the season. These impacts may be the result of State oil and gas activities, the activities of other Federal agencies, and natural processes. Dredging projects related to restoration or flood prevention measures may be directed by the Federal Government for the benefit of growing coastal populations. The COE and State permits would require that the turbidity impacts due to pipeline installation be mitigated by using turbidity screens and other turbidity reduction or confinement equipment. These impacts generally degrade water quality locally and are not expected to last for long periods of time.

Vessel discharges can degrade water quality. Vessels may be service vessels supporting State oil and gas activities. However, the vessels may also be vessels used for shipping, fishing, military activities, or recreational boating. Fortunately, for many types of vessels, most discharges are treated or otherwise managed prior to release through regulations administered by USCG and/or USEPA, and many regulations such as the USCG Ballast Water Management Program and the U.S. Environmental Protection Agency's VGP and sVGP are becoming more stringent as discussed in further detail above. A Congressional moratorium exempted all incidental discharges, with the exception of ballast water, from commercial fishing vessels and nonrecreational, nonmilitary vessels less than 79 ft (24 m) in length, but the moratorium expired on December 18, 2013. The sVGP will provide coverage for those vessels (USEPA, 2011a) once finalized. These regulations should minimize the cumulative impacts of vessel activities.

Accidental releases of oil, gas, or chemicals would degrade water quality during and after the spill until either the spill is cleaned up or natural processes degrade or disperse the spill. These accidental releases could be a result of State oil and gas activity, the transport of commodities to ports, and/or coastal industries. The extent of impact from a spill depends on the release location and the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time.

A major hurricane can affect State oil and gas activities and result in a greater number of coastal oil and chemical spill events with increased spill volume and oil-spill-response times. In the case of an accidental event, it is likely that response efforts would reduce the amount of oil. Coastal water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, hydromodification (e.g., dredging, berm building, boom deployment, etc.), and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree.

Summary and Conclusion

Water quality in coastal waters would be impacted by sediment disturbance and suspension (i.e., turbidity), vessel discharges, erosion, runoff from nonpoint-source pollutants (including river inflows), seasonal influences, and accidental events. These impacts may be a result of a CPA proposed action and the OCS Program, State oil and gas activity, the activities of other Federal agencies (including the military), natural events or processes, or activities related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). The impacts resulting from a CPA proposed action are a small addition to the cumulative impacts on the coastal waters of the Gulf of Mexico because non-OCS activities, including vessel traffic, erosion, and nonpoint source runoff, are cumulatively responsible for a majority of coastal water impacts. Increased turbidity and discharge from a CPA proposed action would be temporary in nature and minimized by regulations and mitigation. Since a catastrophic OCS Program-related accident, though not reasonably foreseeable and not part of a CPA proposed action, would not be expected to occur in coastal waters, the impact of accidental spills is expected to be small. The incremental contribution of the routine activities and accidental events associated with a CPA proposed action to the cumulative impacts on coastal water quality is not expected to be significant for the reasons identified above.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

Various Internet sources were examined and literature searches conducted to assess the availability of new information regarding the water quality and sediment quality in coastal waters that may be pertinent to the CPA. The searches included, but were not limited to, Google, Google Scholar, several USEPA websites, the Gulf of Mexico Sea Grant Programs website, the Coastal Response Research at the University of New Hampshire website, and the NOAA Central Library *Deepwater Horizon*: A Preliminary Bibliography of Published Research and Expert Commentary website. The most recent coastal condition report (USEPA, 2012a), which evaluated the Gulf Coast from 2003 to 2006, found that the overall rating of the Gulf Coast was fair, which is a slight improvement from a previous rating of fair to poor, while the specific ratings for water quality, sediment quality, and the coastal habitat index remained fair, poor, and poor, respectively. Thus, there was not a significant change in the ratings that were reported in the 2012-2017 WPA/CPA Multisale EIS. The ratings reported do not demonstrate any analysis after the *Deepwater Horizon* explosion, spill, and response efforts. A *Deepwater Horizon* oil spill dataset, including extensive chemical analyses of sediment and water, is available online through NOAA (USDOC, NOAA, 2013a). The data set as a whole is not fully interpreted or discussed in context to the condition of the Gulf of Mexico, but since these data are the work of other Federal agencies, state environmental management agencies and BP and its contractors that has been compiled by NOAA, at least some of these data were discussed in the Inter-Agency Joint Analysis Group reports as well as the Operational Science Advisory Reports (OSAT) discussed in the 2012-2017 WPA/CPA Multisale EIS and incorporated by reference into the WPA 233/CPA 231 Supplemental EIS. BOEM expects these data to be considered by the scientific community, and further incorporated into additional reports and published in peer-reviewed literature in the future.

A recent study independently analyzed chemical data from the *Deepwater Horizon* explosion, oil spill, and response and derived an average environmental release rate for hydrocarbons of $(10.1 \pm 2.0) \times 10^6$ kg/d during the *Deepwater Horizon* oil spill, which confirmed the official average leak rate of $(10.2 \pm 1.0) \times 10^6$ kg/d (Ryerson et al., 2011). Another study found that water-soluble petroleum compounds were found to dissolve into the water column to a greater degree than what is typically observed for surface spills (Reddy et al., 2011). Furthermore, the study indicated that the oil contained approximately 3.9 percent PAH's by weight, which results in an estimated release of 2.1×10^{10} grams of PAH's (Reddy et al., 2011; Reddy, official communication 2012). A study of coastal waters sampled for bioavailable PAH's in Grand Isle, Louisiana; Gulfport, Mississippi; Gulf Shores, Alabama; and Gulf Breeze, Florida, was made using passive sampling devices. The study began sampling prior to any shoreline oiling on May 10, 2010, and continued for more than a year. After the oil spill, bioavailable PAH levels were statistically significantly higher than pre-spill levels; however, the PAH levels at all locations had returned to pre-spill levels by March 2011 (Allan et al., 2012). Elevated PAH concentrations were observed again at the Alabama sampling location in summer 2011. The authors of this study suggested that this increase may be due to resuspension of contaminated sediments or continued nearshore cleanup activities. Increased inputs from other sources and/or climatic factors could not be ruled out (Allan et al., 2012). This research confirms information that was extrapolated in the 2012-2017 WPA/CPA Multisale EIS from then existing data on the *Deepwater Horizon* explosion and oil spill, namely that oil from a low-probability catastrophic event under pressure and with more soluble components may become entrained in the water column. As such, this new information has not altered the conclusions from the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

Additional studies examining dispersant use have also been published. Rico-Martinez et al. (2013) found that toxicity testing with various species of marine rotifer revealed that, when COREXIT 9500A was well mixed with oil, the toxicity increased as much as 52 fold. Without mixing, the effect was decreased to 27.6 fold. The authors noted that the rotifer strain from the Gulf of Mexico was most tolerant to *Macondo* oil. Though the authors described the effect as synergistic, other authors have noted that the increased toxicity is actually due to the oil itself (Wu et al., 2012) as the dispersant helps the oil dissolve into the water phase and then become more available. Furthermore, Chakraborty et al. (2012) found that COREXIT 9500 was not toxic to indigenous microbes and that various components of the COREXIT 9500 were degraded. This is part of the ongoing debate that exists with the use of dispersants as a response tool. Dispersants help make the oil more bioavailable so that the oil is subject to increased degradation, including biodegradation; however, oil that is more bioavailable may also be more toxic to some species. Debates also exist within the spill modeling community as to whether the dispersants were effective at keeping the oil from the *Deepwater Horizon* oil spill submerged. Paris et al. (2012) concluded from their modeling efforts that dispersants only marginally decreased the amount of oil surfacing; however, a comment on that work by Adams et al. (2013) notes that the droplet size model used in the Paris et al. work was not appropriate for the conditions of the *Deepwater Horizon* explosion and oil spill. A discussion on the use of dispersants as a response tool is provided in the 2012-2017 WPA/CPA Multisale EIS. As monitoring, experimental research, and modelling research continues to examine the fate of the oil, dispersants, and their components after the *Deepwater Horizon* explosion, oil spill, and response, the results of these different scientific approaches coupled together should improve our understanding of the use of dispersants deep under water.

A study by Gutierrez et al. (2013) explored the role of exopolysaccharides (EPS) in the fate of the oil released during the *Deepwater Horizon* oil spill. The study showed that the amphiphilic EPS produced by the strain of bacteria studied increased the solubilization of aromatic hydrocarbons and enhanced their biodegradation by an indigenous microbial community. The study found that the Gulf was enriched with bacteria that produced amphiphilic EPS and suggested that the enrichment of such bacteria likely contributed to the removal of oil as well as the formation of oil aggregates in surface waters. This study serves as a reminder that natural dispersion of oil takes place, as is noted in the 2012-2017 WPA/CPA Multisale EIS. In other words, if oil should be released into the Gulf of Mexico, some dispersion would be expected even if dispersants were not used in response efforts.

Additionally, some regulations have been updated and strengthened since the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The NPDES general permit for new and existing sources and new discharges in the offshore subcategory of the oil and gas extraction point source category for the western portion of the Gulf of Mexico OCS (GMG290000; USEPA Region 6) was reissued on October 10, 2012, and will expire on September 30, 2017 (USEPA, 2012b). On March 28, 2013, USEPA reissued the Vessel General Permit (VGP) for another 5 years (USEPA, 2013a). The reissued permit, the 2013 VGP, superseded the 2008 VGP on December 19, 2013. The 2013 VGP continues to regulate 26 specific discharge categories that were contained in the 2008 VGP and is more stringent because the permit contains numeric ballast water discharge limits for most vessels and more stringent effluent limits for oil-to-sea interfaces and exhaust gas scrubber washwater (USEPA 2013b).

It is currently impossible to estimate precisely the long-term impacts that the spill from the *Deepwater Horizon* explosion will have on coastal water quality. Various monitoring efforts and environmental studies are underway. More time is needed to fully assess the impacts of the *Deepwater Horizon* explosion, oil spill, and response. Although response efforts decreased the fraction of oil remaining in Gulf waters and reduced the amount of oil contacting the coastline, oil still remains in the environment (USDOC, NOAA, 2011b and 2011c; OSAT-2, 2011). Oil from the *Deepwater Horizon* explosion and resulting oil spill that appears to have been buried along the coast was unearthed by Hurricane Isaac and was reported to be discovered mostly as tarballs in several locations, including Elmer's Island and Grand Isle, Louisiana, as well as possible locations along the Mississippi and Alabama coasts (Burdeau and Reeves, 2012). Testing at Louisiana State University also confirmed a match to oil resulting from the *Deepwater Horizon* explosion with samples collected from Barataria Bay and the Bay Jimmy area, as well as from the Fort Morgan area in Alabama (Overton, official communication, 2012). Nevertheless, this possibility of resuspended oils or remnants due to natural or anthropogenic causes was identified and discussed in the 2012-2017 WPA/CPA Multisale EIS and remains an ongoing concern.

There remains some incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on coastal water quality. Much of this information relates to the *Deepwater Horizon* explosion, oil spill, and response and is continuing to be collected and developed through the NRDA process. These research projects may be years from completion. Few conclusions have been released to the public to date, though as noted above extensive data sets have been released to the public. Some of these data have been discussed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS as part of the discussion of published Federal government reports.

In light of this incomplete and unavailable information, BOEM's subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology. Given the available data on sediments and water quality that have been released, as described above, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS.

4.1.1.2.2. Offshore Waters

BOEM has reexamined the analysis for offshore water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for offshore water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of offshore waters and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.2.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.2.2 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. New information that has become available since those documents were published is presented below.

Impacts on Routine and Accidental Events

The routine activities associated with a CPA proposed action that would impact water quality include the following: discharges during the drilling of exploration and development wells; structure installation and removal; discharges during production; installation of pipelines; workovers of wells; maintenance dredging of existing navigational canals; service-vessel discharges; and nonpoint-source runoff.

During exploratory activities, the primary impacting sources to offshore water quality are discharges of drilling fluids and cuttings. During platform installation and removal activities, the primary impacting sources to water quality are sediment disturbance and temporarily increased turbidity. Impacting discharges during production activities are produced water and supply-vessel discharges. Regulations are in place to limit the toxicity of the discharge components, the levels of incidental contaminants in these discharges, and, in some cases, the discharge rates and discharge locations. Pipeline installation can also affect water quality by sediment disturbance and increased turbidity. Service-vessel discharges might include water with an oil concentration of approximately 15 ppm as established by regulatory standards. Any disturbance of the seafloor would increase turbidity in the surrounding water, but the increased turbidity should be temporary and restricted to the area near the disturbance. There are multiple Federal regulations and permit requirements that would decrease the magnitude of these activities. Impacts to offshore waters from routine activities associated with a CPA proposed action should be minimal as long as regulatory requirements are followed. A detailed impact analysis of the routine impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on offshore waters can be found in Chapter 4.2.1.2.2.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.2.2 of the WPA 233/CPA 231 Supplemental EIS.

Accidental events associated with a CPA proposed action that could impact offshore water quality include spills of oil and refined hydrocarbons, releases of natural gas and condensate, spills of chemicals or drilling fluids, loss of well control, pipeline failures, collisions, or other malfunctions that would result in such spills. Spills from collisions are not expected to be significant. Overall, since major losses of well control and blowouts are rare events, the potential impacts to offshore water quality are not expected to be significant except in the rare case of a low-probability catastrophic event. Although response efforts may decrease the amount of oil in the environment, the response efforts may also impact the environment through, for example, increased vessel traffic and the application of dispersants. Natural degradation processes will also decrease the amount of spilled oil over time. Chemicals used in the oil and gas industry are not a significant risk for a spill because they are either nontoxic, are used in minor quantities, or are only used on a noncontinuous basis. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on offshore waters can be found in Chapter 4.2.1.2.2.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.2.2 of the WPA 233/CPA 231 Supplemental EIS. Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B** of this Supplemental EIS.

Summary and Conclusion

BOEM has reexamined the analysis for offshore water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for offshore water quality presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, as these newly available studies confirmed earlier estimates of hydrocarbon releases and noted the overall return to pre-spill PAH concentrations thus far. Furthermore, efforts to better understand and prevent hypoxia are ongoing as are efforts to better understand the complex process of microbial degradation after the Deepwater Horizon oil spill. Dispersant studies continue to illustrate the ongoing debate on the use of dispersant as a remediation tool. Regulations relevant to the quality of offshore waters continue to be implemented and updated to more stringent standards. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated information in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

Activities in the cumulative scenario that could impact offshore water quality generally include the broad categories of a CPA proposed action and the OCS Program, alternative energy activities, alternate use programs for platforms, sand borrowing, the activities of other Federal agencies (including the military), natural events or processes, State oil and gas activity, and activities related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). Although some of these impacts are likely to affect coastal areas to a greater degree than offshore waters, coastal pollutants that are transported away from shore would also affect offshore environments. Many of these categories noted above would have some of the same specific impacts (e.g., vessel traffic would occur for all of these categories listed above except natural processes).

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas-related impacts include erosion and runoff, sediment disturbance and turbidity, vessel discharges, discharges from exploration and production activities, and accidental releases of oil, gas, or chemicals. Further discussion of these impacts is presented below.

Erosion and runoff from nonpoint sources degrade water quality. Nonpoint-source runoff from onshore support facilities could result from OCS oil- and gas-related activities; however, as discussed below, runoff from OCS activities is not the leading source of contaminant runoff. The leading source of contaminants that impair coastal water quality is urban runoff. Although offshore waters would not be affected as strongly as coastal waters since contaminants would be more diluted by the time they reached offshore areas, in many cases this runoff would still contribute somewhat to the degradation of offshore waters.

Sediment disturbance and turbidity may result from pipeline installation, platform installation and removal, and discharges of muds and cuttings from drilling operations. These impacts generally degrade water quality locally and are not expected to last for long time periods. Furthermore, discharges from drilling platforms are regulated by USEPA through the NPDES permit process; thus, effects from these discharges should be limited.

It should be noted that, since the marine environment is a dynamic system, sediment quality and water quality can affect each other. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., adsorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are (re)suspended, the resuspension can lead to a temporary shift in water quality, including a localized and temporal release of any formally sorbed metals as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982).

Vessel discharges can degrade water quality. Vessels may be service vessels supporting a CPA proposed action or OCS oil- and gas-related activities. Fortunately, for many types of vessels, most discharges are treated or otherwise managed prior to release through regulations administered by USCG and/or USEPA, and many regulations are becoming more stringent. The USCG Ballast Water Management Program became mandatory for some vessels in 2004 (33 CFR part 151 subparts C and D) (USDHS, CG, 2012b). The goal of the program was designed to prevent the introduction of nonindigenous (invasive) species that would affect local water quality. The USCG is amending its regulations on ballast water management by establishing a standard for the allowable concentration of living organisms in ballast water discharged from ships in waters of the U.S and by establishing an approval process for ballast water management systems. The final rule was published on March 23, 2012, in the *Federal Register* and became effective on June 21, 2012 (USDHS, CG, 2012b). The final VGP, issued by USEPA, became effective on December 19, 2008, and was an addition to already existing NPDES permit requirements. The permit increased the NPDES regulations so that discharges incidental to the normal operation of vessels operating as a means of transportation were no longer excluded unless exempted by Congressional legislation. On March 28, 2013, USEPA reissued the VGP for another 5 years (USEPA, 2013a). The reissued permit, the 2013 VGP, superseded the 2008 VGP on December 19, 2013. The 2013 VGP continues to regulate 26 specific discharge categories that were contained in the 2008 VGP and is more stringent because the permit contains numeric ballast water discharge limits for most vessels and more stringent effluent limits for oil-to-sea interfaces and exhaust gas scrubber washwater (USEPA, 2013b). The draft sVGP, once finalized, will authorize discharges incidental to the normal operation of nonmilitary and nonrecreational vessels less than 79 ft (24 m) in length (USEPA, 2011a). These regulations should minimize the cumulative impacts of vessel activities.

Discharges from exploration and production activities can degrade water quality in offshore waters. The USEPA regulates discharges associated with offshore oil and gas exploration, development, and production activities on the OCS under the Clean Water Act's NPDES program. Regulated wastes include drilling fluids, drill cuttings, deck drainage, produced water, produced sand, well treatment fluids, well completion fluids, well workover fluids, sanitary wastes, domestic wastes, and miscellaneous wastes (USEPA, 2012a). The bulk of waste materials produced by offshore oil and gas activities are produced water (formation water) and drilling muds and cuttings. Produced water is the largest waste stream by volume from the oil and gas industry that enters Gulf waters. The National Research Council has estimated the quantity of oil in produced water entering the Gulf per year to be 11,905 bbl of oil contributed from 473,000,000 bbl of produced water, with a resulting oil and grease discharge of approximately 11,905 bbl per year (NRC, 2003, Table D-8, page 200). However, produced water is commonly treated to separate free oil and, as noted above, it is a regulated discharge. Since discharges from drilling and production platforms are regulated by USEPA through the NPDES permit process, the effects from these discharges should be limited. Accidental releases of oil, gas, or chemicals would degrade water quality during and after the spill until either the spill is cleaned up or natural processes degrade or disperse the spill. These accidental releases could be a result of a CPA proposed action or ongoing OCS activity. Actions taking place directly in offshore waters would generally have more significant impacts on offshore waters. The impacts of low-probability catastrophic spills, though not reasonably foreseeable and not part of a CPA proposed action, are discussed in **Appendix B**. The extent of impact from a spill depends on the location of release and the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time (Appendices A.2 and A.3 of the 2012-2017 WPA/CPA Multisale EIS). **Chapter 3.2** of this Supplemental EIS and Chapter 3.2 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS contain more information on accidental releases. Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B** of this Supplemental EIS.

A major hurricane can affect OCS activities and result in a greater number of spill events with increased spill volume and oil-spill-response times. In the case of an accidental event, it is likely that response efforts would reduce the amount of oil. (Refer to **Chapter 3.2.1.9** of this Supplemental EIS and to Chapter 3.2.1.9 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS for further discussion of oil-spill-response considerations.) Offshore water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree.

Non-OCS Oil- and Gas-Related Impacts

Activities not related to a CPA proposed action or the OCS Program that may impact offshore waters include State oil and gas activities, alternative uses of platforms (e.g., aquaculture), sand borrowing, renewable energy activities, the activities of other Federal agencies (including the military), natural events or processes, and activities related to the direct or indirect use of land and waterways by the human population. These activities may result in erosion and runoff, sediment disturbance and turbidity, vessel discharges, natural releases of oil and gas (e.g., seeps), and accidental releases of oil, gas, or chemicals. Further discussion of these impacts is presented below.

Erosion and runoff from point and nonpoint sources degrade water quality. Nonpoint-source runoff from onshore support facilities could result from State oil and gas activities, other industries, and coastal development, as well as OCS oil- and gas-related activities. The leading source of contaminants that impair coastal water quality is urban runoff. Although offshore waters would not be affected as strongly as coastal waters since contaminants would be more diluted by the time they reached offshore areas, in many cases this runoff would still contribute somewhat to the degradation of offshore waters. Urban runoff can include suspended solids, heavy metals and pesticides, oil and grease, nutrients, and organic matter. Urban runoff increases with population growth, and the Gulf Coast region has experienced a 109 percent population growth since 1970, with an additional expected 15 percent increase by 2020 (USDOC, NOAA, 2011a). The National Research Council (2003, Table I-4, page 237) estimated that, on average, approximately 26,324 bbl of oil per year entered Gulf waters from petrochemical and oil refinery industries in Louisiana and Texas. **Chapter 3.1.1.7** of this Supplemental EIS and Chapter 3.1.1.7 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS discuss the various sources of petroleum hydrocarbons that can enter the Gulf of Mexico in further detail. The natural emptying of rivers into the GOM as part of the water cycle may introduce chemical and physical factors that alter the condition of the receiving waters. The Mississippi River introduced approximately 3,680,938 bbl of oil and grease per year from land-based sources (NRC, 2003, Table I-9, page 242) into the waters of the Gulf. Nutrients carried in waters of the Mississippi River contribute to seasonal formation of the hypoxic zone on the Louisiana-Texas shelf. The zone of hypoxia on the Louisiana-Texas shelf is the largest zone in the United States and the entire western Atlantic Ocean (Turner et al., 2005; Figure 4-3 in the 2012-2017 WPA/CPA Multisale EIS). The oxygen-depleted bottom waters occur seasonally and are affected by the timing of the Mississippi and Atchafalaya Rivers' discharges carrying nutrients and freshwater to shelf surface waters. The formation of the hypoxic zone is attributed to a combination of riverborne nutrient inputs supporting phytoplankton growth and shelf stratification, which limit the aeration of bottom waters. The areal extent of mid-summer hypoxia has ranged from 40 to 22,000 km^2 (15 to 8,494 mi^2) and has averaged approximately 13,500 km^2 (5,212 mi^2) during 1985-2007 (Greene et al., 2009). The hypoxic conditions last until local wind-driven circulation mixes the water again. The USEPA has regulatory programs designed to protect the waters that enter the Gulf, including the regulation of point-source discharges. If these and other water quality programs and regulations continue to be administered and enforced, it is not expected that additional oil and gas activities would adversely impact the overall water quality of the region.

Sediment disturbance and turbidity in State waters may result from pipeline installation, platform installation and removal, discharges of muds and cuttings from drilling operations, disposal of dredge materials, sand borrowing, sediment deposition from rivers, and hurricanes. Turbidity is also influenced by the season. These impacts may be the result of other Federal agencies (including the military) or natural processes. State oil and gas activities may have some effect if they take place near offshore waters. Dredging projects related to restoration or flood prevention measures may be directed by the Federal Government for the benefit of growing coastal populations. These impacts generally degrade water quality locally and are not expected to last for long time periods. Furthermore, discharges from drilling platforms are regulated by USEPA through the NPDES permit process, including USEPA-authorized State programs; thus, effects from these discharges should be limited.

Vessel discharges can degrade water quality. Vessels may be service vessels supporting State oil and gas activities. However, the vessels may also be vessels used for shipping, fishing, military activities, or recreational boating. State oil and gas activities, fishing, and recreational boating would have fewer effects on offshore waters except for larger fishing operations and cruise lines, as smaller vessels tend to remain near shore. Fortunately, for many types of vessels, most discharges are treated or otherwise managed prior to release through regulations administered by USCG and/or USEPA, and many regulations such as the USCG Ballast Water Management Program and the USEPA VGP and sVGP are becoming more stringent as discussed in further detail above. A Congressional moratorium exempted all incidental discharges, with the exception of ballast water, from commercial fishing vessels and nonrecreational, nonmilitary vessels less than 79 ft (24 m) in length, but the moratorium expired on December 18, 2013. The sVGP will provide coverage for those vessels (USEPA, 2011a) once finalized. These regulations should minimize the cumulative impacts of vessel activities.

Accidental releases of oil, gas, or chemicals would degrade water quality during and after the spill until either the spill is cleaned up or natural processes degrade or disperse the spill. These accidental releases could be a result of State oil and gas activity, the transport of commodities to ports, and/or coastal industries. Actions taking place directly in offshore waters would generally have more significant impacts on offshore waters. The extent of impact from a spill depends on the release location and the behavior and fate of oil in the water column (e.g., the movement of oil and the rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time.

A major hurricane can affect State oil and gas activities and result in a greater number of spill events with increased spill volume and oil-spill-response times. In the case of an accidental event, it is likely that response efforts would reduce the amount of oil. (Refer to **Chapter 3.2.1.9** of this Supplemental EIS and to Chapter 3.2.1.9 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS for further discussion of oil-spill-response considerations.) Offshore water quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic and the addition of dispersants and methanol to the marine environment in an effort to contain, mitigate, or clean up the oil may also tax the environment to some degree.

Offshore waters, especially deeper waters, are more directly affected by natural seeps since the natural seeps in the Gulf of Mexico are located in offshore waters. Natural seeps are the result of natural processes. Hydrocarbons enter the Gulf of Mexico through natural seeps at a rate of approximately 980,392 bbl/year (a range of approximately 560,224-1,400,560 bbl/year) (NRC, 2003, page 191). Hydrocarbons from natural seeps are considered to be the highest contributor of petroleum hydrocarbons to the marine environment (NRC, 2003, page 33). However, studies have shown that benthic communities are often acclimated to these seeps and may even utilize them to some degree (NRC, 2003, references therein and page 33).

Summary and Conclusion

Water quality in offshore waters may be impacted by sediment disturbance and suspension (i.e., turbidity), vessel discharges, erosion and runoff of nonpoint-source pollutants (including river inflows), natural seeps, discharges from exploration and production activities, and accidental events. These impacts may be a result of a CPA proposed action and the OCS Program, the activities of other Federal agencies (including the military), private vessels, and natural events or processes. To a lesser degree, these impacts may also be a result of State oil and gas activity or activities or related to the direct or indirect use of land and waterways by the human population (e.g., urbanization, agricultural practices, coastal industry, and municipal wastes). Routine activities that increase turbidity and discharges are temporary in nature and are regulated; therefore, these activities would not have a lasting adverse impact on water quality. In the case of a large-scale spill event, degradation processes in both surface and subsurface waters would decrease the amount of spilled oil over time through natural processes that can physically, chemically, and biologically degrade oil. The impacts resulting from a CPA proposed action are a small addition to the cumulative impacts on the offshore waters of the Gulf when compared with inputs from natural hydrocarbon inputs (seeps), coastal factors (such as erosion and runoff), and other non-OCS industrial discharges. The incremental contribution of the routine activities and accidental discharges associated with a CPA proposed action to the cumulative impacts on offshore water quality is not expected to be significant.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

Various Internet sources were examined and literature searches conducted in order to assess recent information regarding the water quality and sediment quality in offshore waters that may be pertinent to the CPA. The searches included, but were not limited to, Google, Google Scholar, several USEPA websites, the Gulf of Mexico Sea Grant Programs website, the Coastal Response Research at the University of New Hampshire website, and the NOAA Central Library *Deepwater Horizon*: A Preliminary Bibliography of Published Research and Expert Commentary website. The searches revealed the release of a *Deepwater Horizon* Oil Spill dataset, including extensive chemical analyses of sediment and water, which is available online through NOAA (USDOC, NOAA, 2013a). The data set as a whole is not fully interpreted or discussed in context to the condition of the Gulf of Mexico, but since these data are the work of other Federal agencies, State environmental management agencies, and BP and its contractors that has been compiled by NOAA, at least some of these data were discussed in the Inter-Agency Joint Analysis Group reports as well as the Operational Science Advisory Reports (OSAT) discussed in the 2012-2017 WPA/CPA Multisale EIS and incorporated by reference into the WPA 233/CPA 231 Supplemental EIS. BOEM expects these data to be considered by the scientific community and further incorporated into additional reports and published in peer-reviewed literature in the future. A recent study independently analyzed chemical data from the *Deepwater Horizon* explosion, oil spill, and response and derived an average environmental release rate for hydrocarbons of $(10.1\pm 2.0) \times 10^6$ kg/d during the *Deepwater Horizon* oil spill, which confirmed the official average leak rate of $(10.2 \pm 1.0) \times 10^6$ kg/d (Ryerson et al., 2011). Another study found that water-soluble petroleum compounds were found to dissolve into the water column to a greater degree than what is typically observed for surface spills (Reddy et al., 2011). Furthermore, the study indicated that the oil contained approximately 3.9 percent PAH's by weight, which results in an estimated release of 2.1×10^{10} grams of PAH's (Reddy et al., 2011; Reddy, official communication, 2012). Another study examined surface sediment samples from two locations 2 km and 6 km (1 mi and 4 mi) from the *Macondo* wellhead (Liu et al., 2012). The limited number of samples examined in the study found that the concentrations of total *n*-alkanes were two orders of magnitude higher and that total PAH's were approximately three times higher at the station closer to the wellhead 1 year after the spill. The study observed clear signs of biodegradation; however, biodegradation in the sediments appears to be slow due to the presence of *n*-alkanes 1 year after the spill as well as the presence of benzene, ethylbenzene, toluene, and xylene (BTEX) and C3-benzenes (Liu et al., 2012). The weathering rate in the sediments appeared to be greater at the station farthest from the well. The authors attributed the weathering in the sediments to biodegradation and dissolution, and they suspected that the slow weathering may be due to low temperatures, low oxygen concentration, and less microbial activity (Liu et al., 2012). However, sorption of oil components onto sediment mineral or organic matter components may also slow the weathering of the oil as oil components associated with the sediment (solid phase) are generally considered less available than oil components associated with the water column (aqueous phase). This research confirms information that was extrapolated in the 2012-2017 WPA/CPA Multisale EIS from then existing data on the *Deepwater Horizon* explosion, namely that oil from a low-probability catastrophic event under pressure and with more soluble components may become entrained in the water column or associated with the sediment. As such, this new information has not altered the conclusions from the 2012-2017 WPA/CPA Multisale EIS or WPA 233/CPA 231 Supplemental EIS.

Studies continue to strive to better understand microbial degradation of hydrocarbons during the *Deepwater Horizon* oil spill. Dubinsky et al. (2013) challenged earlier work by Valentine et al. (2012) that suggested that respiratory succession and circulation patterns were responsible for the succession of bacterial communities that dominated the reported plume from the *Deepwater Horizon* oil spill. Dubinsky et al. (2013) concluded that multiple hydrocarbon-degrading bacteria operated concurrently during the spill, but their relative significance was controlled by changes in hydrocarbon supply, particularly after well intervention measures began. Regardless of the debate of the details regarding microbial remediation, both studies point to the efficiency of microbial degradation of hydrocarbons and thus do not change the conclusions of the 2012-2017 WPA/CPA Multisale EIS or WPA 233/CPA 231 Supplemental EIS.

Additional studies were released that focused on dispersants. Rico-Martinez et al. (2013) found that toxicity testing with various species of marine rotifer revealed that, when COREXIT 9500A was well mixed with oil, the toxicity increased as much as 52 fold. Without mixing, the effect was decreased to 27.6 fold. The authors noted that the rotifer strain from the Gulf of Mexico was most tolerant to *Macondo* oil. Though the authors described the effect as synergistic, other authors have noted that the increased toxicity is actually due to the oil itself (Wu et al., 2012a) as the dispersant helps the oil dissolve into the water phase and then become more available. Furthermore, Chakraborty et al. (2012) found that COREXIT 9500 was not toxic to indigenous microbes and that various components of the COREXIT 9500 were degraded. This is part of the ongoing debate that exists with the use of dispersants as a response tool. Dispersants help make the oil more bioavailable so that the oil is subject to increased degradation, including biodegradation; however, more bioavailable oil may also be more toxic to some species.

Debates also exist within the spill modeling community as to whether the dispersants were effective at keeping the oil from the *Deepwater Horizon* oil spill submerged. Paris et al. (2012) concluded from their modeling efforts that dispersants only marginally decreased the amount of oil surfacing; however, a comment on that work by Adams et al. (2013) notes that the droplet size model used in the Paris et al. work was not appropriate for the conditions of the *Deepwater Horizon* explosion and oil spill. A discussion on the use of dispersants as a response tool is provided in the 2012-2017 WPA/CPA Multisale EIS. As monitoring, experimental research, and modelling research continues to examine the fate of the oil, dispersants, and their components after the *Deepwater Horizon* explosion, oil spill, and response, the results of these different scientific approaches coupled together should improve our understanding of the use of dispersants deep under water.

A study by Gutierrez et al. (2013) explored the role of exopolysaccharides (EPS) in the fate of the oil released during the *Deepwater Horizon* oil spill. The study showed that the amphiphilic EPS produced by the strain of bacteria studied increased the solubilization of aromatic hydrocarbons and enhanced their biodegradation by an indigenous microbial community. The study found that the Gulf was enriched with bacteria that produced amphiphilic EPS and suggested that the enrichment of such bacteria likely contributed to the removal of oil as well as the formation of oil aggregates in surface waters. This study serves as a reminder that natural dispersion of oil takes place, as is noted in the 2012-2017 WPA/CPA Multisale EIS. In other words, if oil should be released into the Gulf of Mexico, some dispersion would be expected even if dispersants were not used in response efforts.

Other new items relevant to the CPA include the latest data on the hypoxic zone in the northern GOM. The zone of hypoxia in the GOM on the Louisiana-Texas shelf was reported to be 5,800 mi^2 (15,022 km^2) in 2013, which is above average (USDOC, NOAA, 2013b). Scientists thought the dead zone would be even larger based on modeling results, but mixed conditions and winds from the west reduced the area from the predicted amount.

Additionally, some regulations have been updated and strengthened since the 2012-2017 WPA/CPA Multisale EIS and the WPA 233/CPA 231 Supplemental EIS. The NPDES general permit for new and existing sources and new discharges in the offshore subcategory of the oil and gas extraction point source category for the western portion of the Gulf of Mexico OCS (GMG290000; USEPA Region 6) was reissued on October 10, 2012, and it will expire on September 30, 2017. On March 28, 2013, USEPA reissued the VGP for another 5 years (USEPA, 2013a). The reissued permit, the 2013 VGP, superseded the 2008 VGP on December 19, 2013. The 2013 VGP continues to regulate 26 specific discharge categories that were contained in the 2008 VGP and is more stringent because the permit contains numeric ballast water discharge limits for most vessels and more stringent effluent limits for oil-to-sea interfaces and exhaust gas scrubber washwater (USEPA 2013b).

As identified in the resource analyses in this Supplemental EIS, the 2012-2017 WPA/CPA Multisale EIS, and WPA 233/CPA 231 Supplemental EIS, incomplete or unavailable information regarding offshore water quality in the WPA may be relevant to reasonably foreseeable significant adverse effects. BOEM has determined that the information is not essential to a reasoned choice among alternatives.

4.1.1.3. Coastal Barrier Beaches and Associated Dunes

BOEM has reexamined the analysis for coastal barrier beaches and associated dunes presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for coastal barrier beaches and associated dunes presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

A detailed description of coastal barrier beaches and associated dunes and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The potential routine-impact producing factors on coastal barrier beaches and associated dunes of the CPA include pipeline emplacements, use of navigation channels by vessel traffic, dredging, and the use and construction of support infrastructure. A detailed impact analysis of the routine impacts of OCS activities associated with a CPA proposed action on coastal barrier beaches and associated dunes can be found in Chapter 4.2.1.3.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.3 of the WPA 233/CPA 231 Supplemental EIS.

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 CPA proposed action are expected to be restricted to temporary and localized disturbances. The 0-1 pipeline landfalls projected in support of a CPA proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods and regulations. Impacts could be reduced or eliminated through modern techniques such as horizontal, directional (trenchless) drilling to avoid damages to these sensitive wetland habitats. Any new processing facilities would not be expected to be constructed on barrier beaches.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which, when combined with channel jetties, generally causes minor and localized impacts on adjacent barrier beaches downdrift of the channel. Updated navigational channels that support the OCS Program are listed in **Table 3-10**.

Dredging activities in these channels are permitted, regulated, and coordinated by COE with the appropriate State and Federal resource agencies. Impacts from these operations are minimal due to requirements for the beneficial use of the dredged material for wetland and beach construction and restoration. Permit requirements further mitigate dredged material placement in approved disposal areas by requiring the dredged material to be placed in such a manner that it neither disrupts hydrology nor changes elevation in the surrounding marsh. Because these impacts occur whether a CPA proposed action is implemented or not, a CPA proposed action would account for a small percentage of these impacts.

Routine activities associated with a CPA proposed action are not expected to adversely alter barrier beach configurations much beyond existing, ongoing impacts in localized areas downdrift of artificially jettied and maintained channels. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to impact coastal barrier beaches and associated dunes of the CPA. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on coastal barrier beaches and associated dunes can be found in Chapter 4.2.1.3.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.3 of the WPA 233/CPA 231 Supplemental EIS.

The main accidental impact-producing factors that would affect coastal barrier beaches and associated dunes are oil spills and cleanup activities. Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B**.

Due to the proximity of inshore spills to barrier islands and beaches, inshore spills pose the greatest threat because of their concentration and lack of weathering by the time they hit the shore and because dispersants are not utilized in inshore waters due to the negative effects on the shallow-water coastal habitats. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. Impacts of a nearshore spill would likely be considered short term in duration and minor in scope because the size of such a spill is projected to be small. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Texas, Mississippi, and Alabama will be expected to have a total of 130-170, 5-10, 3-5, and about 2 spills <1,000 bbl/yr, respectively. Louisiana and Texas are the states most likely to have a spill ≥1,000 bbl occur in coastal waters (refer to Chapter 3.2.1.7.1 of the 2012-2017 WPA/CPA Multisale EIS). For offshore spills, oil would likely be lessened in toxicity when it reaches the coastal environments due to the distance from shore, increased weathering, and the possible use of dispersant. Equipment and personnel used in cleanup efforts can generate the greatest direct impacts to an area, such as the disturbance of beach and foredune sands through foot traffic and mechanized cleanup equipment (e.g., sifters), dispersal of oil deeper into sands and sediments, and foot traffic in marshes impacting the distribution of oils and marsh vegetation. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Currently available information suggests that impacts on barrier islands and beaches from accidental impacts associated with a CPA proposed action would be minimal. Should a spill other than a low-probability catastrophic spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant long-term impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a CPA proposed action. A CPA proposed action would not pose a significant increase in risk to barrier island or beach resources.

Summary and Conclusion

BOEM has reexamined the analysis for coastal barrier beaches and associated dunes presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusions with respect to routine and accidental activities for coastal barrier beaches and associated dunes presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a CPA proposed action, prior and future OCS sales in the Gulf of Mexico, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes that may affect barrier beaches and dunes.

Coastal barrier beaches and associated dunes are vulnerable to many impact-producing factors from both OCS oil- and gas-related impacts and non-OCS oil- and gas-related impacts. Specific OCS oil- and gas-related, impact-producing factors considered in this cumulative analysis include dredging, pipeline emplacement/landfalls, vessel traffic, oil spills, and oil-spill response and cleanup activities. Non-OCS oil- and gas-related activities considered include vessel traffic, river channelization, sediment deprivation, tropical and extra-tropical storm activity, sea-level rise, rapid submergence, and recreational use and tourism.

River channelization, sediment deprivation, tropical and extra-tropical storm activity, sea-level rise, and rapid submergence have resulted in severe and rapid erosion of most of the barrier and shoreline landforms along the coastal areas of the CPA. Coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. 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 from these factors is expected to continue in the future. Federal, State, and local governments have made efforts over the last 10-20 years to slow the landward retreat of shorelines. Frequent intense storms, a relative rise in sea level, and a deficit in the sediment budget (both of which are partly caused by man-made alterations of the environment) are the principal natural causes of barrier island landloss. Other non-OCS oil- and gas-related impacts include development and urbanization, tourism, and recreational activities. In addition, oil spills and oil-spill response and cleanup activities can originate from non-OCS oil- and gas-related activities. While each of these factors can cause negative impacts to barrier beaches and associated dunes, a CPA proposed action would not greatly increase the overall impacts.

OCS Oil- and Gas-Related Impacts

Navigation Channels, Vessel Traffic, and Pipeline Emplacements

Continued navigation channel use and dredging, pipeline emplacements, and construction or continued use of infrastructure in support of a CPA proposed action could impact coastal habitats. The effects to coastal barrier beaches and associated dunes from pipeline emplacements, navigation channel use and dredging, and the construction or continued use of infrastructure in support of a CPA proposed action are expected to be restricted to temporary and localized disturbances. The estimated 0-1 pipeline landfalls projected in support of a CPA proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods such as directional boring. The estimated 0-1 gas processing facilities would not be expected to be constructed on barrier beaches. The use of some existing facilities in support of a CPA proposed action and subsequent CPA proposed lease sales 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; these sediments otherwise might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. However, these efforts would most probably be small in scale within the coastal areas of the CPA. Therefore, effects from these activities are expected to be restricted to temporary and localized disturbances.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which when combined with channel jetties generally causes impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. These impacts would occur whether a CPA proposed action is implemented or not. With the established importance of barrier islands as frontline protection for both coastal wetlands and mainland infrastructure, there are no current or future plans for routing any new navigation channels through barrier islands. A CPA proposed action is estimated to account for less than 1 percent of the service-vessel traffic in the OCS.

A large temporary increase in vessel traffic in the CPA resulted from the *Deepwater Horizon* explosion, oil spill, and response. Large numbers of specialty firefighting, dispersant, and skimmer vessels were concentrated around the Louisiana, Mississippi, and Alabama coasts. Support vessels for berm construction (skimmers, tugboats, sand barges, and dredges) and boom deployment comprised the bulk of the vessel traffic that was in close proximity to barrier islands. Due to the distance from the barrier islands and slow speed of these vessels, it is unlikely these vessels markedly increased erosion rates of these islands. In the short term, these vessels and dredges have the potential to resuspend oiled bottom sediments that may exist in the area of these islands or mainland shorelines. However, it is doubtful that cumulative erosion that results from increased vessel traffic related to catastrophic spills would occur because the probability of catastrophic spills is low. This being the case, there should not be a sustained cumulative increase in the need for supply and support vessels. This is because vessel traffic would either decrease or reach a state of equilibrium to meet the needs of the working wells.

Oil Spills

Due to the proximity of inshore spills to barrier islands and beaches, inshore spills pose the greatest threat. Aging pipelines and infrastructure continue to be problematic, and the potential for spills could exist until they are replaced. Improperly abandoned wells can also have a potential to create spills, especially in the shallow State waters. The number and most probable spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past, and the majority of inshore spills are assumed to be small in scale and short in duration; therefore, impacts would be minor. Oil from most offshore spills, including a low-probability catastrophic spill (more detail in

Appendix B), is assumed to be weathered and normally treated offshore; therefore, most of the toxic components would have dissipated by the time it contacts coastal beaches. 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 the cleanup operations. Cleanup efforts would be monitored to ensure the least amount of disturbance to the areas.

Hurricanes and tropical storms will continue to erode and lower elevations of the barrier islands and to reduce their effectiveness as protection from inland oiling. While the probability of a catastrophic spill like the *Deepwater Horizon* oil spill is low and not reasonably expected, it cannot be entirely ruled out. Regardless of the spill size, some barrier islands could be oiled. Cleanup of these oiled islands and mainland beaches may involve utilizing heavy machinery that further impacts beach and littoral habitats. Based on the current analysis associated with the *Deepwater Horizon* spill, oil from offshore spills can lose many of its volatile and toxic components prior to onshore contact, which would render the residual beached oil low in PAH's and other toxic compounds (OSAT-2, 2011). The form of the residual oil (i.e., tarballs, supratidal buried oil, or surf zone submerged oil mats) could affect its rate of weathering and biodegradation. Some oil may 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. Long-term stressors, including physical effects and the chemical toxicity of hydrocarbons, could lead to decreased primary production, plant dieback, and further erosion (Ko and Day, 2004a); although at some point the impact of cleanup operations exceeds the impact of the remaining oil (OSAT 2010). The OSAT-2 report (2011) found an 86-98 percent depletion of PAH's in the weathered samples that were beached. The buried supratidal samples underwent less biodegradation due to lack of oxygen, but they were estimated to decrease to 20 percent of current levels within 5 years (OSAT-2, 2011). The weathered oils measured in the beach sediment did not surpass any USEPA exceedances for aquatic wildlife, and the National Environmental Benefits Analysis performed by OSAT (2010) determined that the residual oil remaining after cleanup efforts would be less damaging to the habitat and associated resources than continuing the cleanup effort.

The State of Louisiana constructed barrier sand berms along the beaches of barrier islands in an attempt to keep the oil from reaching the coast. Such measures can impact barrier islands through increasing compaction, altering currents, and removing sand supplies needed for natural barrier island formation. These berms resulted in changes to the ecosystems they were intended to protect (Martinez, et al., 2011).

The barrier beaches of Deltaic Louisiana have the greatest rates of erosion and landward retreat of any known in the Western Hemisphere and are 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. Mechanized cleanup was used in Alabama and Florida to remove tarballs from recreational beaches. While substantial amounts of sand were not removed, but sifted in place to remove tarballs, it is too soon to determine if there will be long-term effects on specific interstitial organisms that live in the sands of the beach face.

The reduction in slope on the beach face, loss of dune elevation, and development of scour inlets resulting from past hurricane activity contribute to future vulnerability to oil spills of the once-protected coastal inland habitats. The barrier and mainland beaches will continue to be susceptible to spills associated with vessel collisions, pipeline breaks, and refinery accidents near or at transfer facilities by the ports of Houston and Beaumont. Hurricane Ike resulted in numerous oil spills along the Texas coast. Future spills that would affect these areas are possible as refinery and offshore production facilities and pipelines continue to age and become more vulnerable to storm and hurricane damage.

Most of the Gulf Coast is comprised of sandy beaches with little vegetation directly on the beach head, except in parts of Louisiana. The more vulnerable wetland vegetation is located behind the dune or beach systems where it is less likely to come in contact with spilled oil from the OCS. Beach cleanup techniques involving heavy machinery can drive oil farther into the sediment; however, new machinery allows the sand to be sifted in place and returned to the beach after the oil is removed. Some oil may 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.

Non-OCS Oil- and Gas-Related Impacts

Vessel Traffic

Maintenance dredging of barrier inlets and bar channels is expected to occur, which when combined with channel jetties generally causes impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. These impacts would occur from necessary channel maintenance to accommodate non-OCS vessel traffic. More than 98 percent of total vessel traffic is not associated with a CPA proposed action. With the established importance of barrier islands as frontline protection for both coastal wetlands and mainland infrastructure, there are no current or future plans for routing any new navigation channels through barrier islands.

Oil Spills

Non-OCS spills can occur as a result of import tankers, barge, or shuttle tanker accidents during transit or offloading, State-related oil production activities, and various kinds of petroleum product transfer accidents. Coastal or inland spills have the potential to have greater effects on beaches and dunes because the oil would not have the chance to weather and degrade before reaching the resource. Effects of non-OCS oil- and gas-related spills would be similar to OCS oil- and gas-related spills.

River Channelization and Beach Protection

Over the course of geological history since the peak of the last ice age 18,000 years ago, the barrier islands have migrated toward the present coast. The Gulf-facing coasts of the barrier islands have been eroded by the steady rise in sea level. Historically, as the Gulf's coast retreated, the landward side of the islands has extended and has been built up by sand deposits from over wash during storms. The vegetated dunes prevent some degree of sediment transport to the back side of the dune and increase the potential for erosion due to wash back on the dune face, and as a result, the islands are getting narrower.

Human disturbance has hastened the erosion of barrier beaches and dunes. Channel deepening and widening along the Mississippi River and other major coastal rivers, in combination with channel training and bank stabilization work, has resulted in the reduced delivery of sediment to the eroding deltas along the mouths of the rivers and to the offshore barrier islands. This, coupled with beach building and stabilization projects utilizing mined sands, jetties, groins, and other means of sediment capture, is depriving natural restoration of the barrier beaches through sediment nourishment and sediment transport.

Subsidence, erosion, and dredging of inland coastal areas, with the concurrent expansion of tidal influences, continually increase tidal prisms around the Gulf. These changes may result in the opening and deepening of many new tidal channels that connect to the Gulf and inland waterbodies. These incremental changes would cause adverse impacts to barrier beaches and dunes. 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, and by increasing or redirecting the erosional energy of waves (Morton, 1982). 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.

Other Anthropogenic and Natural Processes

Adverse effects on barrier beaches and dunes have resulted from changes to the natural dynamics of water and sediment flow along the coast. Some of these changes can be attributed to man-made alterations to the environment. This can happen in an attempt to control catastrophic floods and change the natural environment to better accommodate navigation on waterways used to support OCS and non-OCS seaborne traffic. Sea-level rise and coastal subsidence with tropical and extra-tropical storms exacerbate and accelerate the erosion of coastal barrier beaches along the Gulf Coast. Both the western edge of the Louisiana coast and the eastern Texas coast in the WPA received major damage as a result of Hurricanes Katrina, Rita, Gustav, and especially Ike. Texas barrier islands and mainland beaches lost elevation and vegetative cover as a result of the erosion accompanying the storm-driven debris and sheer tidal surge. The reduction in storm protection once provided by barrier islands will result in further conversion of freshwater marsh to either open water or salt marsh. Due to such hurricane-induced changes, the cumulative effect of additional storms has the potential to further erode barrier islands unless restoration methods are implemented.

Barrier beaches along coastal Louisiana have experienced severe erosion and landward retreat (marine transgression) because of natural processes enhanced by human activities. Adverse effects on barrier beaches and dunes have resulted from changes to the natural dynamics of water and sediment flow along the coast. This can happen due to anthropogenic attempts to control catastrophic floods and change the natural environment to better accommodate navigation on waterways used to support OCS Program- and non-OCS Program-related vessel traffic. Sea-level rise and coastal subsidence, along with tropical and extra-tropical storms exacerbate and accelerate the erosion of coastal barrier beaches along the Gulf Coast of Louisiana. The CPA coast received major damage as a result of Hurricanes Katrina, Rita, and Gustav.

The central Gulf Coast (i.e., Louisiana, Mississippi, Alabama, and western Florida) and the associated barrier islands and beaches have experienced an increase in frequency of high-intensity hurricanes and tropical storms over the past several years. As a result of past powerful hurricanes (i.e., Hurricanes Katrina, Rita, and Gustav), changes in barrier island topography and decreases in beach elevation potentially increased the probability for oiling farther up the beach head in some locations. Due to the more gentle slopes, removal of beach ridges, and cuts into the mainland barrier beaches, the remnant transition zone between the water and the current beach ridge may be more vulnerable to spills. In some areas along the Louisiana coast, barrier islands were severely damaged, resulting in either heavily degraded beachfront elevations and ridges or submergence of the island from sediments being redistributed by the storm surge. In coastal Louisiana, dune-line heights have been drastically reduced by the storm activity. The Isle Dernieres and Chandeleur Island chains experienced beach erosion and losses in elevation. In Mississippi and Alabama, dune elevations exceed those in Louisiana but have been reduced to some extent due to storm activity. Hurricane Katrina completely inundated the western side of Dauphin Island, Alabama, decreasing elevations to less than 2 m (7 ft). Hurricane Gustav then completely overwashed the western edge of the island, resulting in large changes to the island's shape and topography (USDOI, GS, 2008).

Hurricane Rita in September 2005 severely impacted the shoreface and beach communities of Cameron Parish in southwest Louisiana. These barriers lost elevation and vegetative cover as a result of the erosional forces accompanying the storm surge and scour from storm-driven debris (Barras, 2007a). The removal of vegetative cover and scour scars provides an avenue for additional erosion to occur as a result of inlet formations and tidal rivulets. If the topography is modified, it may result in hydrological changes that enable further sediment transport from the islands. This provides pathways for further erosion and saltwater intrusion into the less salt-tolerant interior vegetated habitats of the islands. The loss of elevation, combined with the shoreline retreat and removal of vegetation further aggravated by the hurricanes, allows for the expansion of the overwash zone. This lessens the pre-storm protection provided by these barrier islands. The reduction in island elevation results in less frontline protection to valuable marshes and makes urban and industrial areas protected by these marshes at a higher risk (USDOC, NMFS, 2007).

Hurricanes and tropical storms will remain a part of the Gulf Coast weather pattern and will continue to affect the elevations of barrier islands, mainland beaches, and dunes. Depending on storm frequency and intensity, it may be possible for coastal restoration and protection projects to mitigate some of the physical damage to these areas.

Recreational Use and Tourism

Most barrier beaches in Louisiana are relatively inaccessible for regular recreational use because they are in coastal areas with limited road access. Few of these beaches have been, or are likely to be, substantially altered to accommodate recreational or industrial construction projects in the near future.

Mississippi has coastal beaches behind the barrier islands that are accessible for recreational use, and the barrier islands experience extensive recreational use by boaters.

Most barrier beaches in Alabama and Florida are accessible to people for recreational use because of road access, and their use is encouraged. 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. Recreational vehicles and even hikers have caused problems where road access is available and the beach is wide enough to support vehicle use, as in Alabama, Florida, and a few places in Louisiana. Areas without road access have limited impacts by recreational vehicles. There will continue to be seaside real-estate development where road access is available. The protection of dunes, beaches, and coastal environments will be regulated through the Coastal Management Programs (CMP's) of the State. This assures that projects are constructed consistent with the Federal CZMA guidelines in order to preserve the integrity of the coastal ecosystem.

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 *Deepwater Horizon* explosion, spill, and response further impacted the Louisiana coast. The Mississippi, Alabama, and West Florida coasts have been impacted by storm activity; sea-level rise; the *Deepwater Horizon* explosion, spill, and response; development; recreational use; and tourism. The Texas coast has experienced landloss because of a decrease in the volume of sediment delivered to the coast because of channelization and damming of coastal rivers and subsidence along the coast. Storm-induced changes in hydrology have, in some cases, changed the current regime responsible for stabilizing the barrier islands. Beach stabilization projects are considered by coastal geomorphologists and engineers to accelerate coastal erosion. Beneficial use of maintenance dredged materials and other restoration techniques could be required to mitigate some of these impacts.

The impacts of oil spills from both OCS and non-OCS sources to the Gulf Coast should not result in long-term alteration of landforms if the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes. The majority of inshore spills are assumed to be small in scale and short in duration; therefore, impacts would be minor. Oil from most offshore spills is expected to be weathered and dissipated by the time it would contact coastal beaches. 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 the cleanup operations. Some contact to lower areas of sand dunes is expected. These contacts would not result in significant destabilization of the dunes. Cleanup efforts would be monitored to allow the least amount of disturbance to the areas. 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 further erosion, particularly if oil is carried onto dunes by hurricanes.

Under a CPA proposed action, 0-1 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 and that had been placed on barrier islands using older techniques that left canals or shore protection structures, have caused and would continue to cause barrier beaches to narrow and breach.

Most barrier beaches in Alabama and Florida are accessible to people for recreational use because of road access, and their use is encouraged. Recreational use of barrier beaches can be intense depending on the area. In 2012, the Gulf Islands National Seashore had approximately 4.9 million visitors (USDOI, NPS, 2013). This ranked it the ninth most visited National Parks Unit, placing it ahead of parks like the Grand Canyon and Yosemite. Excessive recreational use can result in damage to dunes resulting from the loss of dune stabilizing plants. Destabilized dunes are more easily eroded by winds waves and human traffic. Restoration to repair and mitigations to minimize damages to beaches from both natural and human impacts are common in many of the developed beachfronts. Areas without road access have limited impacts by recreational vehicles.

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 severe local impacts and accelerate the 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, reduction in sand budgets, and beach stabilization structures.

A CPA proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in localized areas downdrift of artificially jettied and maintained channels. A CPA proposed action may extend the life and presence of facilities in eroding areas, which would cause continued erosion in those areas. A CPA proposed action is not expected to increase the probabilities of oil spills beyond the current estimates. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

The extent of impacts from the *Deepwater Horizon* explosion, oil spill, and response to coastal barrier beaches and associated dunes remains unclear at this time. This information is being developed through the NRDA process, data are still incoming and have not been made publicly available, and it is expected to be years before the information is available. Where this incomplete information is relevant to reasonably foreseeable impacts, what scientifically credible information is available was used in its stead and applied using accepted scientific methodologies. Although it may be relevant to reasonably foreseeable adverse impacts, this incomplete or unavailable information is not essential to a reasoned choice among alternatives. Compared with other impacting factors on coastal barrier beaches and dunes, the incremental contribution of a CPA proposed action to the cumulative impacts to these resources is expected to be small.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search was conducted for information published on barrier beaches and dunes, and various Internet sources were examined to determine any recent information regarding barrier beaches and dunes. Sources investigated include BOEM; the U.S. Department of the Interior, Geological Survey (USGS); National Wetlands Research Center; the USGS Gulf of Mexico Integrated Science Data Information Management System; Gulf of Mexico Alliance; State environmental agencies; USEPA; and coastal universities. Other websites from scientific publication databases (including Science Direct, Elsevier, the NOAA Central Library National Oceanographic Data Center, and JSTOR) were checked for new information using general Internet searches based on major themes. Most new and pertinent information has been the result of *Deepwater Horizon*-related research, and these studies have provided insight into many aspects of the spill and its effects as it relates to beach and dune environments.

Various studies examined changes to microbial communities after exposure to crude oil and/or dispersant, such as increased dominance in fungal communities (Bik et al., 2012) and increased abundance of hydrocarbon degraders (Kostka et al., 2011). Hamdan and Fulmer (2011) demonstrated inhibition of hydrocarbon degrading bacteria by exposure to dispersant, and Zuijdgeest and Huettel (2012) found that COREXIT caused faster penetration of PAH's into sandy sediments, resulting in slowed degradation under anaerobic conditions. Other studies showed that biostimulation with nutrients or organic matter enhanced biodegradation of crude oil by autochthonous microbial consortia (Nikolopoulou et al., 2013; Horel et al., 2012; Mortazavi et al., 2012). A study of the bacteria present in tarballs collected from beaches suggested that tarballs can act as reservoirs for bacteria, particularly human pathogens such as *Vibrio vulnificus* (Tao et al., 2011).

Still other studies focused on determining the source of tarballs and dispersant-related chemicals. Mulabagal et al. (2013) found that tarballs on Alabama beaches originated from the *Deepwater Horizon* explosion and oil spill, while Hayworth and Clement (2012) traced dispersant-related chemicals found in nearshore and inland water samples from the Orange Beach, Alabama, vicinity to local stormwater discharge rather than COREXIT.

While the recent research has provided new information regarding impacts to coastal beaches and dunes from oil spills, this new information does not change the conclusions of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because such a low-probability catastrophic event is unlikely to occur and because BOEM has already considered the potential irreversible effects to coastal beaches and dunes in **Appendix B** of this Supplemental EIS.

As identified in the resource analyses above and in Chapter 4.2.1.3 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, incomplete or unavailable information regarding coastal barrier beaches and associated dunes in the CPA may be relevant to reasonably foreseeable significant adverse effects. BOEM has determined that the information is not essential to a reasoned choice among alternatives.

4.1.1.4. Wetlands

BOEM has reexamined the analysis for wetlands presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for wetlands presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

A detailed description of wetlands and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.4 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The potential routine impact-producing factors on wetlands of the CPA include pipeline emplacement, construction, and maintenance; navigation channel use (vessel traffic) and maintenance dredging; disposal of OCS oil- and gas-related wastes; and use and construction of support infrastructure in 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. A detailed impact analysis of the routine impacts of OCS activities associated with a CPA proposed action on wetlands can be found in Chapter 4.2.1.4.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.4 of the WPA 233/CPA 231 Supplemental EIS.

It is expected that impacts of pipelines would be reduced or eliminated through mitigation, such as horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive wetland habitats. Although maintenance dredging of navigation channels and canals in the CPA is expected to occur, a CPA 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 wetlands. Secondary impacts to wetlands from a CPA proposed action would result from OCS oil- and gas-related vessel traffic, contributing to the erosion and widening of navigation channels and canals. Overall, the impacts to wetlands from routine activities associated with a CPA proposed action are expected to be low due to the small length of projected onshore pipelines, the minimal contribution to the need for maintenance dredging, and the mitigation measures that would be used to further reduce these impacts.

Accidental disturbances resulting from a CPA proposed action, mainly oil spills, have the potential to cause plant mortality and permanent loss of wetlands of the CPA. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on wetlands can be found in Chapter 4.2.1.4.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.4 of the WPA 233/CPA 231 Supplemental EIS.

Offshore oil spills resulting from a CPA proposed action would have a low probability of contacting and damaging wetlands along the Gulf Coast, except in the case of a low-probability catastrophic event, which is not reasonably expected and not part of a CPA proposed action (refer to **Appendix B**). This is because of the distance of the spill to the coast, the likely weathered condition of oil (through evaporation, dilution, and biodegradation) should it reach the coast, and because wetlands are generally protected by barrier islands, peninsulas, sand spits, and in some cases by currents. However, because the protective capacity of barrier islands has been reduced (due to land lost in hurricanes and anthropogenic factors; refer to **Chapter 4.1.1.3**), there is a greater potential for the oiling of coastal wetlands during an accidental event. The causes of coastal and offshore oil spills are summarized in **Chapters 3.1.1.7 and 3.3.5.2**. Although the probability of occurrence is low, the greatest threat from an oil spill to wetland habitat is from an inland spill as a result of a nearshore vessel accident or pipeline rupture. Wetlands in the northern Gulf of Mexico are in moderate- to high-energy environments; therefore, sediment transport and tidal stirring should reduce the chances for oil persisting in the event that these areas are oiled. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment, chemical treatments, and personnel used for cleanup can 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. In addition, an assessment of the area covered, oil type, and plant composition of the wetland oiled should be made prior to choosing remediation treatment. These treatments could include mechanical and chemical techniques with onsite technicians. Overall, impacts to wetland habitats from an oil spill associated with activities related to a CPA proposed action would be expected to be low and temporary because of the nature of the system, regulations, and specific cleanup techniques.

For example, Michel et al. (2013), Kokaly et al. (2013), and Mishra et al. (2012) demonstrate that understanding the extent of the oil spill in terms of the length of shoreline affected and the penetration into wetlands from the shoreline will help in setting the visual contexts to detect possible long-term recovery trends. This includes the usefulness of monitoring techniques such as remote sensing (of oil impacts), bioremediation, bioaugmentation, and microbial degradation, along with natural weathering to help in the recovery of oiled marsh vegetation (DeLaune and Wright, 2011; Horel et al., 2012; Liu et al., 2012; Tao and Yu, 2013; Natter et al., 2012; Beazley et al., 2012). Other techniques, such as the use of barriers such as booms and sand berms, did not work as well as planned (Martinez et al., 2011; Jones and Davis, 2011; Zengel and Michel, 2013). Research has shown that marsh vegetation recovers from many disturbances, including oil exposure (DeLaune and Wright, 2011; Silliman et al., 2012). Even though some marsh vegetation is more resilient than others, all marsh vegetation will be adversely impacted if there is 100-percent oil coverage of the plant (Lin and Mendelssohn, 2012; Wu et al., 2012b; Mishra et al., 2012). The impact of oil on resident and transient marsh nekton and arthropods has been shown to be short term in nature, with these communities near pre-spill levels a year after the *Deepwater Horizon* oil spill (Moody et al., 2013; McCall and Pennings, 2012).

Summary and Conclusion

The impacts to wetlands from activities associated with a CPA proposed action are expected to be low because 0-1 pipeline landfalls are projected, 0-1 new gas processing facilities are expected, and the contribution from a CPA proposed action to the need for maintenance dredging would be minimal. The wetlands that would be associated with a CPA proposed action have a minimal probability for oil-spill contact.

Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a CPA proposed action, prior and future OCS sales in the Gulf of Mexico, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes that may affect wetland resources.

Wetlands are vulnerable to many impact-producing factors from OCS oil- and gas-related impacts and non-OCS oil- and gas-related impacts. Specific OCS oil- and gas-related, impact-producing factors considered in this cumulative analysis include the following: (1) oil spills; (2) OCS oil- and gas-related vessel traffic; (3) construction of OCS oil- and gas-related infrastructure and support structure (including pipelines); and (4) waste disposal. Other non-OCS oil- and gas-related impact-producing factors would potentially impact wetland resources, including the following: (1) State oil and gas activities; (2) non-OCS oil- and gas-related vessel traffic and navigation canals; (3) coastal infrastructure and development; (4) natural processes (including hurricanes and subsidence,); and (5) sea-level rise (natural causes of subsidence are combined with subsidence caused by extraction and other man made alterations). While each of these factors can cause negative impacts to wetlands, a CPA proposed action would not greatly increase the overall impacts.

OCS Oil- and Gas-Related Impacts

Oil Spills

The potential for coastal/inland oil spills creates the greatest concern for coastal wetlands due to the proximity of the spills to these vegetated areas. Aging infrastructure including refineries, onshore production facilities, platforms, and pipelines would continue to be an increasing source of potential spills.

Over 3,000 production platforms in the Gulf are over 20 years old and were constructed prior to the modern structural requirements that increase endurance to hurricane force winds (Casselman, 2010). Improperly capped or marked abandoned wells also add to the possibility for future oil spills as a result of leaks or vessel collisions. Future spills from these types of facilities would be less likely because these older facilities are gradually either structurally updated to withstand larger storms or replaced at the discretion of the owner/operator.

Oil from offshore spills is less likely to reach the coastal wetlands in the same condition it was released due to weathering, dispersant treatment, and blockage by barrier islands and shorelines. However, erosion of these barriers by Hurricanes Katrina and Rita decreased the level of protection afforded the mainland (USDOC, NMFS, 2007a). Flood tides may now 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. Any adverse impacts that may occur to wetland plants are expected to be short lived, generally less than 1 year.

Spills that occur in or near the Chandeleur or Mississippi Sounds could affect wetland habitat in or near the Gulf Islands National Seashore (135,458 ac; 545,818 ha) including its Wilderness Area (4,080 ac; 1,651 ha), and the Breton National Wildlife Refuge (18,273 ac; 7,395 ha) with its Wilderness Area (5,000 ac; 2,023 ha). Because of their natural history, these areas are considered areas of special importance. They also 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. The inlets that connect the Mississippi Sound with the marsh-fringed estuaries and lagoons within the islands are narrow, so a small percentage of the oil that contacts the Sound side of the islands would be carried by the tides into interior lagoons.

The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related, commercial and recreational activities remain the same. Therefore, the coastal waters of Louisiana, Mississippi, and Alabama would have a total of 200, 30, and 10 spills <1,000 bbl/yr, respectively, from all sources. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, Louisiana, Mississippi, and Alabama would have a total of 130-170, 3-5, and about 2 spills <1,000 bbl/yr, respectively.

The *Deepwater Horizon* oil spill was the largest spill recorded in the GOM and resulted in the oiling of an extensive portion of the northern Gulf Coast shoreline from east of the Texas/Louisiana State line to northwest Florida (Florida Panhandle) (OSAT-2, 2011). This event must be considered in the cumulative baseline due to the volume of oil released and the geographic area affected. However, unlike other historic large spills (*Exxon Valdez* and *Ixtoc I*), the oil was released and treated in deep water nearly 77 km (48 mi) from shore, and the spill occurred in an unconfined open ocean as opposed to a sheltered embayment. All of these factors contribute to the weathering and detoxification of the oil that reached the shoreline. It is too early to determine the cumulative long-term effect of this spill and its contribution to the ongoing marsh loss or the acceleration of that loss. While low-probability catastrophic spills, which are not reasonably foreseeable and not part of a CPA proposed action, could occur in the future as a result of human error, new regulations focusing on improved safety, more regulatory checks, and inspections should decrease the already small likelihood of the occurrence of such spills. Accidental spills as a result of a low-probability catastrophic event, which is not reasonably foreseeable and not part of a CPA proposed action, are discussed in **Appendix B**.

Vessel Traffic

Navigation channels in the coastal areas of the CPA support both OCS and non-OCS vessel traffic. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process. This is evident along the Texas coast where heavy traffic using the Gulf Intracoastal Waterway has accelerated the erosion of existing salt marsh habitat.

BOEM conservatively estimates that there are approximately 4,850 km (3,013 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS oil- and gas-related traffic in the EPA, CPA, and WPA (**Table 3-7**) and that the average canal is widening at a rate of 0.99 m/year (3.25 ft/year). Gulfwide, the average canal widening rate results in a total annual landloss of approximately 831 ac/yr (336 ha/yr). Therefore, over the 40-year cumulative activities scenario, landloss in Federal navigation channels could total approximately 33,221 ac (13,444 ha). Total landloss in these areas can be caused by multiple factors, including saltwater intrusion, hurricanes, and vessel traffic. The OCS oil- and gas-related traffic constitutes a larger percent of the total vessel traffic (OCS oil- and gas-related and non-OCS oil- and gas-related) in the CPA (12-16%) than in the WPA (3-5%). All service vessels associated with EPA actions are assumed to use CPA navigational canals while inland and constitute less than 1 percent of the total vessel traffic. Assuming that vessel traffic alone was the sole source of erosion, the rate of landloss would be related to the usage of those canals by both OCS oil- and gas-related vessels and non-OCS oil- and gas-related vessel traffic. Using the estimated proportion of OCS oil- and gas-related vessel traffic as a measurement of erosion, BOEM conservatively estimates the OCS oil- and gas-related contribution to bank erosion over the 40-year cumulative scenario to be 2,766-3,645 ac (1,119-1,475 ha). This number is considered conservative because open waterways were included in the total length of Federal navigation channels, vessel size was not taken into consideration, and there are sources of erosion to navigation canals other than vessel traffic alone.

In the Louisiana Coastal Master Plan (State of Louisiana, Coastal Protection and Restoration Authority, 2012), it is estimated that up to 1,750 mi^2 (4,500 km^2) of land will be lost in the next 50 years (or approximately 896,000 ac [362,600 ha] of land in the next 40 years). Using BOEM's conservative estimate of approximately 2,360 km (1,470 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic in the LCA (**Table 3-7**) and the average canal widening rate of -0.99 m/yr (-3.25 ft/yr), a total landloss of approximately 16,190 ac (6,550 ha) in navigation canals may be estimated over the next 40 years. Using this estimate and comparing it with the total expected landloss in coastal Louisiana over the next 40 years, BOEM estimates that approximately 2 percent of the total landloss in Louisiana will occur due to saltwater intrusion, hurricanes, and vessel traffic (OCS oil- and gas-related and non-OCS oil- and gas-related) in navigation canals. Because OCS oil- and gas-related vessel traffic constitutes only 12-16 percent of the total vessel traffic in the CPA, BOEM conservatively estimates that OCS oil- and gas-related vessel traffic would contribute <0.5 percent (or <2,647 ac [1,071 ha]) of the landloss in coastal Louisiana in the next 40 years.

Depending upon the regions and soils through which canals were dredged, their secondary adverse impacts may be more locally significant than direct impacts. The OCS oil- and gas-related vessel traffic is expected to result in some level of dredging activity associated with the expansion of offshore platforms or onshore transfer or production facilities if needed. The primary indirect impacts from dredging would be wetland loss as a result of saltwater intrusion or vessel-traffic erosion. However, the primary support, transfer, and production facilities used for OCS oil- and gas-related activities are located along armored canals and waterways, thus minimizing marsh loss. In the foreseeable future, there will be a continuing need for dredged material for coastal restoration, wetland creation and, to some extent, offshore sediments (e.g., sand, etc.) needed for beach restoration and hurricane protection. Alternative dredged-material disposal methods can be beneficially used for wetland creation or restoration as required by COE's permitting program.

Coastal Infrastructure and Pipelines

Various kinds of onshore facilities service OCS development. Projected new facilities that are attributed to the OCS Program and a CPA proposed action would not be in wetland areas. State and Federal permitting agencies discourage the placement of new facilities or expansion of existing facilities in wetlands. Any impacts upon wetlands from existing facilities are expected to be mitigated. Because of existing capacity, no additional expansion into wetland areas is expected.

Activities that would further accelerate wetland loss include additional construction of access channels to shoreline staging areas and expansion or construction of onshore and offshore facilities (receiving and transfer facilities or fabrication of production platforms). BOEM projects 0-1 new gas processing facilities and 0-1 new pipeline landfalls for a CPA proposed action. However, based on the most current information available, there is only a very slim chance that either would result from a CPA proposed action, and if a new gas processing facility or pipeline landfall were to result, it would likely occur toward the end of the 40-year analysis period. The likelihood of a new gas processing facility or pipeline landfall is much closer to zero than to one (Dismukes, official communication, 2013a). A more detailed description of coastal infrastructure is provided in **Chapter 4.1.1.23.1**.

Modern pipeline installation methods that use horizontal (trenchless) drilling allow pipelines to be installed under coastal habitats such as barrier islands and beaches as well as fringe marshes, and therefore, eliminate or greatly reduce impacts to these habitats. The addition of corrosion preventatives to the pipeline itself reduces the probability of accidental leakage from aging pipelines. These techniques, in combination with "tie ins" to existing Federal or State pipelines with shore connections, further reduces the number of new pipeline landfalls and their cumulative impact. While impacts are greatly reduced by mitigation techniques, remaining impacts may 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). The majority (over 80%) of previous OCS oil- and gas-related direct landloss is estimated to be caused by OCS pipelines (Turner and Cahoon, 1987). These are seaward of the inland CZM boundary to the 3-mi (5-km) State/Federal boundary offshore of Louisiana, Mississippi, and Alabama. Of those pipelines, about 8,000 km (4,971 mi) cross wetland and upland habitat, and they mainly occur in Louisiana. The remaining 7,400 km (4,595 mi) of pipeline cross waterbodies (Johnston et al., 2009). 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). There is a total (OCS and non-OCS) of approximately 23,285 km (14,460 mi) of pipelines through Louisiana coastal wetlands. The majority of OCS pipelines entering State waters ties into existing pipeline systems and does not result in new landfalls. Pipeline maintenance activities that disturb wetlands are very infrequent and are mitigated to the maximum extent practicable. Such activities would be subject to review by the State of Louisiana through its coastal use permit requirements and through the Clean Water Act section 404 and Rivers and Harbors Act section 10 permits.

The widening of OCS pipeline canals does not appear to be an important factor contributing to OCS oil- and gas-related direct landloss. This is because few pipelines are open to navigation, and the impact width does not appear to be significantly different from that for open pipelines closed to navigation. Based on the projected coastal Louisiana wetlands loss of from 419,000 to 925,000 ac (169,000-374,000 ha) (Couvillion et al., 2013), landloss resulting from new OCS pipeline construction represents <1 percent of the total expected wetlands loss for that time period. This estimate does not take into account the present regulatory programs and modern installation techniques. Today, pipeline canals are much narrower than in the past because of advances in technology and improved methods of installation. These advances are due to a greater awareness among regulatory agencies and industry (Johnston et al., 2009). The magnitude of impacts from OCS oil- and gas-related pipelines is inversely proportional to the quantity and quality of mitigation techniques applied. Pipelines with extensive mitigation measures appeared to have minimal impacts, while pipelines without such measures contributed to significant habitat changes. Impacts can be minimized or altogether avoided through proper construction methods, mitigation, and maintenance. BOEM is not a permitting agency for onshore pipelines. The permitting agencies are COE and the State in which the activity has occurred or would occur. Therefore, it would be the responsibility of COE and the States to ensure that wetland impacts resulting from pipeline construction are properly mitigated and monitored. Throughout the 40-year life of a CPA proposed action, a majority of the already old pipeline distribution and production systems would continue to age. This could result in an increasingly large inventory of pipelines and support structures that would need to be replaced or repaired. The replacement and repair of the inland pipeline system may temporarily impact wetlands in the pipeline corridors, but if proper mitigation is implemented and maintained, impacts should be minimal and temporary. In the absence of the replacement of these aging pipelines, the potential risk for spills and leaks will increase in nearshore, inland, and offshore waters.

Waste Disposal

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 oil- and gas-related produced water into inshore waters has been discontinued, so all OCS oil and gas produced waters are discharged into offshore Gulf waters in accordance with NPDES permits, or injected. Produced waters from the OCS are not expected to affect coastal wetlands. Produced sands, oil-based or synthetic-based drilling muds and cuttings, along with fluids from well treatment, workover, and completion activities from OCS wells, would be transported to shore for disposal in existing disposal facilities approved by USEPA for handling these materials. Sufficient disposal capacity is assumed to be available in support of a CPA proposed action. Because of wetland-protection regulations, no new waste disposal site would be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation.

Non-OCS Oil- and Gas-Related Impacts

State Oil and Gas

Impacts from State onshore oil and gas activities are expected to occur as a result of oil spills, dredging for new canals, maintenance, and usage of existing rig access canals and drill slips, and for preparation of new well sites. Indirect impacts from dredging new canals for State onshore oil and gas development and from the maintenance of the existing canal network are expected to continue. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be placed in existing disposal areas or because alternate bank disposal techniques would be used. The alternate bank disposal technique creates gaps to maintain hydrological connections and tidal circulation important in maintaining a functioning wetland. State onshore oil and gas activities also contribute to vessel traffic and the wetland impacts associated with such traffic, as described above.

Other impacts stem from State oil and gas activity. Locally, subsidence may be due to the extraction of large volumes of oil and gas, sulfur, and salt from subsurface reservoirs (Morton, 2003; Morton et al., 2002 and 2005), but subsidence associated with this factor seems to have slowed greatly over the last three decades as the reservoirs are depleted. Subsidence leads to drowning of marsh plants and conversion to open water. Non-OCS oil- and gas-related oil spills can occur in coastal regions as a result of import tankers, barge or shuttle tanker accidents during transit or offloading, coastal oil production activities, and various kinds of petroleum product transfer accidents. Numerous wetland areas have declined or been destroyed as a result of oil spills caused by pipeline breaks or tanker accidents.

Oil stresses the wetland communities, making them more susceptible to saltwater intrusion, drought, disease, and other stressors (Ko and Day, 2004). The past discharge of saltwater and drilling fluids associated with oil and gas development has been responsible for the decline or death of some local marshes (Morton, 2003).

Vessel Traffic and Navigation Canals

Vessel traffic in the CPA includes commercial shipping, support for oil and gas activities, commercial and recreational fishing vessels, pleasure boating, and other types of traffic. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process. In many cases this erosion results in wetland loss. Navigation channels require routine maintenance dredging. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed upon existing disposal areas. However, due to the fluid nature of the dredged material, indirect impacts may occur as a result of disposal site widening and converting lower elevations to higher ground. This elevation change could convert existing wetland areas to uplands. Alternative dredged material disposal methods can be used to enhance and create coastal wetlands.

Net landloss due to navigation canals alone can be calculated by comparing erosion rates with beneficial activities such as land gained through the use of dredged sands. BOEM anticipates that, over the next 40 years, if current trends in the beneficial use of dredged sand and sediment are simply projected based on past land additions (U.S. Dept. of the Army, COE, 2009b), approximately 50,000 ac (20,234 ha) may be created or protected in the LCA through dredged materials programs. Subtracting projected landlosses of 16,190 ac (6,550 ha) caused by bank widening of navigation channels in the LCA from land added or protected by beneficial uses of dredged material, an estimated net gain of 33,800 ac (13,700 ha) between the years 2013 and 2063 could occur (refer to the calculations in "OCS Oil- and Gas-Related Impacts" above).

Depending upon the region and the dredged soil type, secondary adverse impacts of canals may be more locally significant than direct impacts. Additional wetland losses may be generated by the secondary impacts of saltwater intrusion, flank subsidence, freshwater-reservoir reduction, and deeper tidal penetration. A variety of mitigation efforts have been initiated to protect against direct and indirect wetland loss. The failure to maintain mitigation structures that reduce canal construction impacts can have substantial impacts upon wetlands. These localized impacts are expected to continue.

Navigation channels contribute to the negative effects from saltwater intrusion (Gosselink et al., 1979; Wang, 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, saltwater 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 water to saltwater and ultimately to open-water systems. Another example is the construction of the Mississippi River Gulf Outlet, which transformed many of the cypress swamps east of the Mississippi River below New Orleans into open water or areas largely composed of marsh vegetation (*Spartina)* among old, dead cypress tree trunks.

Onshore activity that would further accelerate wetland loss includes additional construction of access channels (for instance at fabrication yards) and onshore action needed for the construction of new well sites and the expansion or construction of onshore production facilities or receiving and transfer facilities. Most of these facilities would be located in Louisiana and would minimally impact wetlands. Management activities, including erosion protection and restoration along the edges of these canals, can significantly reduce canal-widening impacts on wetland loss (Johnston et al., 2009; Thatcher et al., 2011).

Coastal Infrastructure and Development

The development of wetlands for agricultural, residential, industrial, commercial, and silvicultural (forest expansion) uses would continue but with more regulatory and planning constraints. Impacts from these developments are expected to continue in coastal regions around the around the Gulf.

Development pressures in the coastal regions of Texas have been primarily the result of tourism and residential beach side development in the Galveston and Bolivar Peninsula areas. In Galveston, recreation and tourist developments have been particularly destructive. These trends are expected to continue, but since Hurricane Ike, redevelopment is being coordinated with the natural resource agencies in an effort to assure compatibility of the new construction with the coastal environment to minimize impacts.

Development pressures in the coastal regions of Louisiana, Mississippi, Alabama, and Florida have caused the destruction of large areas of wetlands. In coastal Louisiana, the most destructive developments have been the inland oil and gas industry projects, which have resulted in the dredging of huge numbers of access channels. Agricultural, residential, industrial, and commercial developments have caused the most destruction of wetlands in Mississippi, Alabama, and Florida. In Florida, recreational and tourist developments have been particularly destructive. These trends are expected to continue. During the next 40 years, from 419,000 to 925,000 ac (169,000-374,000 ha) of wetlands would be lost from the Louisiana coastal zone (Couvillion et al., 2013), and 1,600-2,000 ha (647-809 ac) would be lost from the Mississippi coastal zone. Wetland losses in the coastal zones of Alabama and Florida are assumed to be comparable with those in Mississippi.

Infrastructure associated with State oil and gas activity has taken a tremendous toll on coastal wetlands, particularly in Louisiana, primarily due to construction of access canals, drilling slips, and pipeline canals (Turner et al., 1994). Many pipelines carry product from both OCS and non-OCS sources. Impacts from pipeline construction due to non-OCS oil and gas activity are similar to impacts due to OCS oil and gas activity. Infrastructure that serves the transportation of foreign oil, such as oil ports, can have wetland impacts to the extent they are constructed on or adjacent to wetlands. New and existing pipeline channels would continue eroding, largely at the expense of wetlands; however, protective channel armor may be added at a later date. The current regulatory programs, modern construction techniques, and mitigations have reduced recent impacts to wetlands from pipeline installation.

Existing regulations and development permitting procedures indicate that development-related wetland loss may be slowed. Wetland damage would be minimized through the implementation of CZMA guidelines and enforceable policies, COE regulatory guidelines for wetland development, and various State and Federal coastal development programs. Examples of these programs are the Coastal

Impact Assistance Program (CIAP), the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), and the Louisiana Coastal Protection and Restoration Authority (refer to Chapter 4.2.1.4.4 of the 2012-2017 WPA/CPA Multisale EIS).

Renewable energy facility construction could potentially impact wetlands, if for instance transmission lines coming from offshore wind turbines necessitated construction of onshore transmission substations in the coastal zone. Impacts to wetlands would be negligible.

Natural Processes

Along with increased human activities, the recent increase in intensity and frequency of hurricanes in the Gulf (Stone et al., 2004) has greatly impacted the system of protective barrier islands, beaches, and dunes and associated wetlands along the Gulf Coast. Intense storms typically erode all of the vegetation and soil from some areas of marsh, leaving behind a body of water, as seen with Hurricane Isaac. These storm events will continue to impact the Gulf of Mexico coast.

Natural subsidence has caused wetland loss through compaction of Holocene strata (the rocks and deposits from 10,000 years ago to present). Stephens (2010) has identified faulting mechanisms in coastal Louisiana that actually may be causing what appears to be subsidence. He found that the "Northern Gulf of Mexico continental margin is segmented by northwest-southeast trending transfer fault zones related to Mesozoic rifting."

It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 26 km^2/yr (10 mi^2/yr) over the next 50 years. This would be expected to result in an additional net loss of 1,326 km^2 (512 mi^2) 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 562 km^2 (217 mi^2) of land change (primarily wetlands to open water) (Barras, 2006). Based on the analysis of the latest satellite imagery, approximately 212 km^2 (82 mi^2) of additional open-water habitat was in areas primarily impacted by Hurricane Katrina (e.g., Mississippi River Delta Basin, Breton Sound Basin, Pontchartrain Basin, and Pearl River Basin) (Barras, 2007b and 2009). Also, 256 km^2 (99 mi^2) of open-water habitat was in areas primarily impacted by Hurricane Rita (e.g., Calcasieu/Sabine Basin, Mermentau Basin, Teche/Vermilion Basin, Atchafalaya Basin, and Terrebonne Basin). Barataria Basin contained approximately 46.6 km^2 (18 mi^2) of new open-water habitat caused by both hurricanes. These new open-water habitats represent landloss caused by the direct removal of wetlands. They may also indicate transitory changes of wetlands to open water caused by remnant flooding, removal of aquatic vegetation, and scouring of marsh vegetation. However, it is possible that the apparent increase in open water is partly due to water-level variation attributed to normal tidal and meteorological variation between satellite images. The presence of strong tropical storms is a routine background condition in the Gulf that must be taken into consideration. Coastal change from storms in the area included both beach erosion and the erosion of channels where water continues to flow seaward to the Gulf of Mexico (Doran et al., 2009). Eroded barriers that once protected the wetlands behind them were severely eroded by the storms. These factors have led to a steep increase in the recent landloss projections cited above (Couvillion et al., 2013).

Sea-Level Rise

There is increasing new evidence of the importance of the effect of sea-level rise (or marsh subsidence) as it relates to the loss of marsh or changes in marshes, marsh types, and plant diversity (Spalding and Hester, 2007). The Spalding and Hester (2007) study shows that the very structure of coastal wetlands would likely be altered by sea-level rise because community shifts will be governed by the responses of individual species to new environmental conditions.

Gulf Coast wetlands tend to occur at low elevations, often between 1 and 2 ft (0.3-0.6 m) above sea level. It is obvious that if current projections are realized, and for example, sea level increases by 3.5 ft (1.1 m) in Galveston, Texas, by the year 2100 (USEPA, 2013b), most of Texas' coastal wetlands would be under water well before that time, in spite of organic accretion. A more conservative estimate of sea-level rise, known as the AR4 scenario, calls for an increase (globally) of 16 in (41 cm) by 2100 (NRC, 2010). Even this rate of increase would be likely to drown large areas of Gulf Coast wetlands, especially when Relative Sea Level Rise is considered. Since 1870, global sea level has risen by about 8 in (20 cm) (USEPA, 2013b). Even at current measured rates of relative sea-level rise, vast areas of Gulf coastal wetlands can be expected to convert to open water as low-lying coastal marshes are inundated (refer to **Chapter 3.3.4.1**).

Summary and Conclusion

Cumulative impacts to wetlands are caused by a variety of factors, including pipeline emplacement, construction, dredging, oil spills, coastal development, and natural phenomena. The impacts to wetlands from activities associated with a CPA proposed action are expected to be low because 0-1 pipeline landfalls are projected, 0-1 new gas processing facilities are expected, and the contribution from a CPA proposed action to the need for maintenance dredging would be minimal.

Wetlands are most vulnerable to inshore or nearshore oil spills, which are primarily localized in nature. Spill sources include vessel collisions, pipeline breaks, and shore-based transfer, refining, and production facilities. A CPA proposed action would have a minimal probability for causing oil-spill contact with wetlands. This reduced risk is due to the distance of the offshore facility to wetland sites, beach and barrier island topography (although reduced locally post-Hurricanes Katrina, Rita, Gustav, and Ike), and product transportation through existing pipelines or pipeline corridors. Wetlands can still be at risk for offshore spills, but the risks are minimized by distance, time, sea conditions, and weather. Offshore spills related to a CPA proposed action are not expected to reach wetlands with toxicity approaching that of the initial release because of distance to shore and weathering. If they do reach shore, only light localized impacts to inland wetlands would occur. If any inshore spills occur, they will likely be small and at service bases or other support facilities, and these small-scale local spills would not be expected to severely affect wetlands beyond local impacts.

Development pressures in the coastal regions of Texas have been primarily the result of tourism and residential beach side development. These trends are expected to continue, but since Hurricane Ike, redevelopment is being coordinated with the natural resource agencies in an effort to assure compatibility of the new construction with the coastal environment to minimize impacts. The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and have 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 in the Gulf of Mexico. Wetland loss is also expected to continue in coastal Mississippi, Alabama, and Florida, but at slower rates. The incremental contribution of a CPA proposed action to the cumulative impacts on coastal wetlands is expected to be small.

A CPA proposed action represents a small (>5%) portion of the OCS impacts that will occur over the 40-year analysis period. Impacts associated with a CPA proposed action are a minimal part of the overall OCS impacts. The incremental contribution of a CPA proposed action to the cumulative impacts on coastal wetlands is expected to be small.

BOEM acknowledges that there remains incomplete and unavailable information that may be relevant to reasonably foreseeable significant impacts on wetlands. This incomplete or unavailable information includes potential data on the *Deepwater Horizon* explosion, oil spill, and response that may be forthcoming. As there is substantial information available since the *Deepwater Horizon* explosion, oil spill, and response, which is included in this Supplemental EIS, BOEM believes that the incomplete or unavailable information regarding effects of *Deepwater Horizon* explosion, oil spill, and response on wetlands would likely not be essential to a reasoned choice among alternatives. This information will certainly not be available within the timeline contemplated in the NEPA analysis of this Supplemental EIS. Regardless of the costs involved, it is not within BOEM's ability to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS. The BOEM subject-matter experts have used what scientifically credible information is available in their analyses, and applied it using accepted scientific methodology.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search was conducted for information published on northern Gulf of Mexico wetland communities, and various Internet sources were examined to determine any recent information regarding these communities. Sources investigated include BOEM, the USGS National Wetlands Research Center, the USGS Gulf of Mexico Integrated Science Data Information Management System, Gulf of Mexico

Alliance, State environmental agencies, USEPA, and coastal universities. Other websites from scientific publication databases (including Science Direct, Elsevier, the NOAA Central Library National Oceanographic Data Center, and JSTOR) were checked for new information using general Internet searches based on major themes. A recently released report provides an update on the status and trends of coastal wetlands (Dahl and Stedman, 2013). Numerous studies have been published regarding impacts of the *Deepwater Horizon* explosion, oil spill, and response.

While the recent research has provided much new information regarding impacts to wetlands from oil spills, this new information does not change the conclusions of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because such a low-probability catastrophic event is unlikely to occur and because BOEM has already considered the potential irreversible effects to marshes, such as erosion and permanent loss, in Appendix B (Section 5.2.2.6) of the 2012-2017 WPA/CPA Multisale EIS.

As identified in the resource analyses above and in Chapter 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, BOEM has identified incomplete or unavailable information regarding wetlands in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant adverse effects. BOEM has determined that the information is not essential to a reasoned choice among alternatives.

Summary and Conclusion

BOEM has reexamined the analysis for wetlands presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for wetlands presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

4.1.1.5. Seagrass Communities

BOEM has reexamined the analysis for seagrass communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for seagrass communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

A detailed description of seagrass communities and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.5 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.5 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since those documents were published is presented below.

Submerged vegetation distribution and composition depend on an interrelationship among a number of environmental factors that include water temperature, depth, turbidity, salinity, turbulence, and substrate suitability (Kemp, 1989; Onuf, 1996; Short et al., 2001). Marine seagrass beds generally occur in shallow, relatively clear, protected waters with sand bottoms (Short et al., 2001). Freshwater submerged aquatic vegetation (SAV) occurs in the low-salinity waters of coastal estuaries (Castellanos and Rozas, 2001). Seagrasses and freshwater SAV's provide important nursery and permanent habitat for sunfish (*Lepomis* sp.), killifish (*Fundulus* sp.), shrimp (Penaeidae and Palaemonidae), crabs (*Callinectes* sp. and Xanthidae), drums and seatrout (Sciaenidae), flounder (*Paralicthys* sp.), and several other nekton species, and they provide a food source for species of wintering waterfowl and megaherbivores (Rozas and Odum, 1988; Rooker et al., 1998; Castellanos and Rozas, 2001; Heck et al., 2003; Orth et al., 2006). In the northern Gulf of Mexico from south Texas to Mobile Bay, seagrasses occur behind barrier islands in bays, lagoons, and coastal waters (Figure 4-4 of the 2012-2017 Multisale EIS), while SAV's occur in the upper freshwater regions of estuaries and rivers (Onuf, 1996; Castellanos and Rozas, 2001; Handley et al., 2007).

Impacts of Routine and Accidental Events

The potential routine impact-producing factors on seagrass communities of the CPA are the construction of pipelines, canals, navigation channels, and onshore facilities; maintenance dredging; and vessel traffic (e.g., propeller scars). A detailed impact analysis of the routine impacts of OCS activities associated with a CPA proposed action on seagrass communities can be found in Chapter 4.2.1.5.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.5 of the WPA 233/CPA 231 Supplemental EIS.

Routine OCS activities in the CPA that may impact seagrasses are not expected to significantly increase as a result of the proposed action because minimal action-associated nearshore activities and infrastructure are expected. There is only one potential pipeline landfall and only a minor increase in vessel traffic (2%) projected as a result of the CPA proposed action. Any work in and around submerged aquatic vegetation, especially seagrasses, is highly regulated by multiple State and Federal programs; as such, considerable mitigation is expected to reduce the undesirable effects on submerged vegetation beds. This includes the rerouting of pipelines, avoidance of vegetated communities, use of turbidity curtains, or the use of directional boring techniques. Local outreach programs decrease the occurrence of prop scarring in grass beds; however, channels utilized by OCS vessels are typically away from exposed submerged vegetation beds. Because of these requirements and implemented programs, along with the beneficial effects of natural flushing (e.g., from winds and currents), any potential effects from routine OCS activities on submerged vegetation in the CPA are expected to be short term, localized, and not significantly adverse.

Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to change community structure, decrease growth rates, cause death, or cause a decline in ecological services by seagrass communities of the CPA. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on seagrass communities can be found in Chapter 4.2.1.5.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.5 of the WPA 233/CPA 231 Supplemental EIS.

Accidental events possible with a CPA proposed action that could adversely affect submerged vegetation beds include nearshore and inshore spills connected with the transport and storage of oil. The greatest possibility of a spill is from a vessel accident or pipeline rupture; however, because pipelines can be shut off, ships carry limited amounts of oil, and response vessels can more easily access nearshore areas, it is expected that the resulting spill would be smaller and shorter than an uncontrolled offshore spill or blowout, resulting in short-term and localized impacts. Additionally, extreme tides and/or wind events are the only time that submerged aquatic vegetation is typically exposed to the air-water interface where most oil would be floating. As such, seagrasses are not expected to come in direct contact with surface oil; however, if oil did come in contact with seagrasses, the results could range from the sloughing of epiphytes to death. Offshore oil spills that occur in a CPA proposed action area are less likely to contact seagrass communities than are inshore spills. If the temporal and spatial duration of the spill is big enough, an offshore spill could affect submerged vegetation communities, although the oil would be substantially more weathered and spills would be outside the barrier islands, peninsulas, sand spits, and currents that protect most seagrass beds. An offshore spill would result in more sinking oil (e.g., tarballs and patties) than an inshore spill that could become entrained within seagrass root and leave complex near the seafloor. Cleanup efforts in response to a spill can also negatively impact submerged aquatic vegetation. Close monitoring and restrictions on the use of bottom-disturbing equipment and vessel operations in and around SAV's would be needed to avoid or minimize those impacts. The floating nature of nondispersed crude oil, the regional microtidal range, the dynamic climate with mild temperatures, and the amount of microorganisms that consume oil would alleviate prolonged effects on submerged vegetation communities. It has been shown that short-term effects from an offshore spill could have little impact on specific seagrass communities. Fodrie and Heck (2011) found that, after the *Deepwater Horizon* oil spill, there were few immediate or catastrophic changes in seagrass-based nekton communities in Alabama, Florida, and Louisiana seagrass communities. Also, safety and spill-prevention technologies are expected to continue to improve and will decrease detrimental effects to submerged vegetation from a CPA proposed action. Overall, impacts to submerged vegetation from an accidental event related to a CPA proposed action are expected to be minimal due to the distance of most activities from the submerged vegetation beds and because the likelihood of an accidental event of size, location, and duration reaching submerged vegetation beds remains small.

Summary and Conclusion

BOEM has reexamined the analysis for seagrass communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for seagrass communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated information provided in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

Of all of the activities in the cumulative scenario found in **Chapter 3.3**, dredging, oil spills/pipelines, hydrological changes due to channelization, and storm events present the greatest threat of impacts to submerged vegetation communities.

OCS Oil- and Gas-Related Impacts

The OCS activities that threaten submerged vegetation are infrastructure construction, pipelines, dredging, and oil spills including low-probability catastrophic spills (**Appendix B**). Infrastructure emplacement, such as a pipeline landfall, and the vessel activity and dredging associated with the emplacement may affect submerged vegetation beds. From 2012 to 2051, offshore oil and gas activities are projected to generate 0-1 pipeline landfalls per CPA lease sale; this is equivalent to less than 1 pipeline landfall a year for a CPA proposed action. Pipelines are heavily regulated and permitted, and they are likely to be required to be sited away from submerged vegetation. Although, submerged vegetation communities can be scarred by boat anchors, keels, and propellers, and by equipment associated with seismic surveys conducting routine OCS oil and gas activities (Sargent et al., 1995; Dunton et al., 1998), in general, channels used by OCS vessels are away from exposed submerged vegetation beds.

In support of inshore petroleum development, the oil and gas industry performs dredging that impacts lower-salinity submerged vegetation. Generally, dredging generates the greatest overall OCS oil- and gas-related risk to submerged vegetation by uprooting and burying plants, decreasing oxygen in the water and reducing water clarity in an area. Mitigation may be required to reduce undesirable impacts of dredging to submerged vegetation. The most effective mitigation for direct impacts to submerged vegetation beds is avoidance, but there are other mitigation techniques in place to lessen the effects of unavoidable disturbances. Because vessel traffic is only expected to increase by 2 percent as a result of a CPA proposed action, there are expected to be few if any new channels dredged or widened specifically for a proposed action. Additionally, dredging is expected only in areas that do not support submerged vegetation beds. The OCS oil- and gas-related dredging and vessel traffic related to a CPA proposed action remains a subset of all dredging (refer to the "Non-OCS Oil- and Gas-Related Impacts" section below) and traffic issues from all sources in the Gulf.

Other OCS activities that could cause adverse effects to submerged vegetation are accidental oil-spill events. These are generally rare and small-scale, but they do add to the possible cumulative damage to submerged vegetation ecosystems. Inshore oil spills generally present a greater risk of adversely impacting submerged vegetation and seagrass communities than do offshore spills. Inshore spills would be expected to be smaller in size than offshore spills but, because the oil from an inshore spill would not be weathered, it could be potentially more toxic. Because of the subtidal life history, microtides in the Gulf of Mexico, and the hydrophobic nature of oil, little to no direct permanent mortality of seagrass beds is expected as a result of oil-spill occurrences (Zieman et al., 1984; Gab-Alla, 2000). The only exception to this is during an extreme low-tide event when some of the shallower seagrasses may be exposed below the air-water interface as water levels drop and oil coats the plants. These tides are not normal and typically occur during winter or spring tides or when a low tide coincides with an offshore wind. There has been no documented occurrence of extensive oiling of seagrasses in the Gulf of Mexico except during the *Ixtoc I* spill. During this spill, damage to seagrass meadows was temporary (Baca et al., 1982; Tunnell and Dokken 1980); however, outside the Gulf of Mexico, changes in biomass, cover, and species composition of seagrass communities have been observed post-spills (Nievales, 2009). Epifauna could also be exposed to oil during one of these events and a high mortality rate could be expected; however, many of these species can rapidly repopulate an area once the vegetation returns. Oil spills alone would typically have little impact on submerged vegetation beds and associated epifauna because nondispersed oil floats and because of the microtidal range of the Gulf of Mexico.

During and after a spill event, the response effort can cause significant scarring and trampling of submerged vegetation beds with increased vessel traffic in the area. Preventative measures (booms, berms, and diversions) can alter water hydrology and salinity, which could harm the beds and their associated communities. There is a small probability of an offshore spill contacting beds, and inshore spills would be small and short-lived; oil exposure is not expected to increase over current levels with a CPA proposed action. In the rare event of a large spill such as the *Deepwater Horizon* oil spill, there would be similar impacts to submerged vegetation as a smaller spill, just over a larger area and over a longer time period (**Appendix B**).

Non-OCS Oil- and Gas-Related Impacts

Other influences on submerged vegetation can include non-OCS oil- and gas-related dredging and vessel traffic, changes in salinity and nutrient inputs (Waycott et al., 2009; Orth et al., 2006), and storm events. Maintenance dredging of navigation channels may also affect submerged vegetation beds by increasing turbidity and allowing larger vessels with larger wakes access to more areas. This dredging is necessary for a variety of reasons, including State onshore oil and gas activities and commercial barging. The COE performs maintenance dredging of navigation channels to help sustain the outcome of the original dredging event. This generally occurs every 2-5 years despite a CPA proposed action. Impacts on seagrasses from dredging activities can also result from of the installation of new channels; however, there are no new channels expected to be created as a result of a CPA proposed action. Scarring of seagrass beds by other vessels (e.g., support vessels for State oil and gas activities, commercial shipping, cruise ships, fishing vessels, and recreational watercraft) is an increasing concern in coastal areas, particularly along the Texas coast (Dunton et al., 1998; State of Texas, Parks and Wildlife Department, 1999; Pulich and Onuf, 2007). Scarring most commonly occurs in water depths less than 2 m (~6 ft) as a result of boats operating in too shallow water (Zieman, 1976; Sargent et al., 1995; Dunton et al., 1998). Consequently, their propellers, and occasionally their keels, plow through vegetated bottoms, tearing up roots, rhizomes, and whole plants, leaving a furrow that is devoid of submerged vegetation (Zieman, 1976; Dawes et al., 1997). A few State and local governments have instituted management programs that have resulted in reduced scarring, which could decrease bed patchiness. For example, the State of Florida Seagrass Outreach Partnership consists of citizens, researchers, law enforcement officers, and marine resource managers and was created to reduce boating impacts to seagrass meadows through education. The State of Texas has also enacted House Bill 3279, which makes it illegal to uproot seagrasses in all coastal waters.

Saltwater intrusion resulting from river channelization and canal dredging is a major cause of coastal habitat deterioration (including submerged vegetation communities) (Boesch et al., 1994). Productivity and species diversity associated with SAV habitat in the coastal marshes of the GOM are greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989; Lirman et al., 2008). Due to increased salinities farther up the estuaries, some salt-tolerant species of submerged vegetation (including seagrasses) are able to populate areas farther inland and outcompete the dominant submerged aquatic vegetation species (Longley, 1994). Large shifts in salinities can decrease seagrass and submerged aquatic vegetation populations and decrease their ecological function for juvenile fishes and invertebrates. Increased nutrients from diversions, runoffs, or flooding events can cause eutrophication in local waters. This can increase phytoplankton and epiphytic growth, which will shade and decrease submerged vegetation (Larkum et al., 2006; Orth et al., 2006). This relationship is complex and depends on multiple environmental factors.

Tropical cyclone activity in the Gulf of Mexico (USDOC, NOAA, 2005) is also common and can have a significant impact on seagrasses and submerged aquatic vegetation. Storms can remove or bury submerged beds of seagrasses and the barrier islands that protect them from storm surges. A seagrass bed already weakened due to other anthropogenic impacts could be substantially more susceptible to damage from a storm event. Hurricanes can result in the burial of seagrasses and the eroding of channels through seagrass beds. Burial occurs when storm-generated waves wash sand from the seaward side of barrier islands and deposit it on the shallow seagrass-containing areas on the back side of the islands. Having evolved in an environment where burial occurs regularly, many seagrasses are equipped to rapidly extend vertical rhizomes to recover from burial (Marba and Duarte 1994, Marba et al. 1994, Cabaço et al., 2008). Storms can also erode new passes through the islands, removing all the seagrass in its path (Michot and Wells, 2005). Over time, seagrass can recolonize the new sand flats on the shoreward side, and the natural processes of sand movement rebuild the islands. Overall, the effects of hurricanes on seagrass beds are highly variable and can range from significant changes in seagrass community quality and composition (Maiaro, 2007) to no substantial effects (Byron and Heck 2006). However, combined with other stressors (Orth et al., 2006), impacted seagrass beds may fail to recover after a storm event.

Summary and Conclusion

In general, a CPA proposed action would cause a minor incremental contribution to impacts on submerged vegetation from dredging, pipeline installations, potential inshore oil spills, and boat scarring. Dredging and shading generate the greatest overall risk to submerged vegetation, while naturally occurring hurricanes cause direct damage to beds. The implementation of proposed lease stipulations and mitigation policies currently in place, the small probability of an oil spill, and because flow regimes are expected to change further reduce the incremental contribution of stress from a CPA proposed action to submerged vegetation.

Unavailable information on the effects to submerged vegetation from the *Deepwater Horizon* explosion, oil spill, and response (and thus changes to the submerged vegetation baseline in the "Affected Environment" (Chapter 4.2.1.5.1 of the 2012-2017 WPA/CPA Multisale EIS) makes an understanding of the cumulative effects less clear. BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to submerged vegetation. Relevant data on the status of submerged vegetation beds after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and based it upon accepted methods and approaches. Nevertheless, BOEM believes that incomplete or unavailable information regarding the effects of the *Deepwater Horizon* explosion, oil spill, and response on submerged vegetation is not essential to a reasoned choice among alternatives in the cumulative effects analysis. In light of this, the incremental contribution of a CPA proposed action remains minor compared with the cumulative effects of other factors, including dredging, hurricanes, and vessel traffic.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of various printed and Internet sources was conducted for any recent information published regarding coastal submerged vegetation. Sources investigated include BOEM, USDOC/NOAA, the USGS National Wetlands Research Center, the USGS Gulf of Mexico Integrated Science Data Information Management System, Seagrass Watch, Gulf of Mexico Alliance, State environmental agencies, USEPA, and coastal universities. Other websites from scientific publication databases (including Science Direct, SCIRUS, Google Scholar, Elsevier, Pro Quest, and JSTOR) were checked for new information using general Internet searches based on major themes. New information available that is relevant to a CPA proposed activity includes information related to responses of seagrass species that were potentially exposed to *Macondo* oil. Moody et al. (2013) found that the recruitment of many species of invertebrates in an Alabama marsh was not negatively impacted by the *Macondo* oil spill. Although focused on the marsh, this study is important because many of the species found in the marsh are also found in the seagrass. Dubinsky et al. (2013) did note that exposure to *Macondo*-related sediments that were contaminated with PAH's resulted in Gulf killifish (*Fundulus grandis*) having multitissue molecular, genomic, and developmental responses, suggesting that oil exposure could result in population-level effects. The Gulf killifish is typically found in marsh habitats, but it can be found in seagrass habitats (Schofield and Fuller, 2013). Because of the cosmopolitan distribution of the Gulf killifish, exposure at a level to have more than a localized response would be in the case of a low-probability catastrophic spill.

There remains uncertainty regarding the impacts of the *Deepwater Horizon* explosion, oil spill, and response on submerged vegetation. For submerged vegetation in Louisiana, Mississippi, and Alabama, BOEM cannot definitively determine that the incomplete or unavailable information being developed through the NRDA process may be essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Nevertheless, the ongoing research on submerged vegetation after the *Deepwater Horizon* explosion, oil spill, and response is being conducted through the NRDA process. These research projects may be years from completion, and data and conclusions have not been released to the public. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline contemplated in the NEPA analysis of this Supplemental EIS. In light of this incomplete and unavailable information, BOEM's subject-matter experts have used credible scientific information that is available and applied it using scientifically accepted methodology.

4.1.1.6. Live Bottoms (Pinnacle Trend and Low Relief)

BOEM has reexamined the analysis for live bottoms (both Pinnacle Trend and Low Relief) presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for live bottoms presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.6 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is presented in the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The potential routine impact-producing factors on live bottoms of the CPA are anchoring, infrastructure emplacement, drilling effluent and produced-water discharges, and infrastructure removal. These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of live bottoms in the CPA. A detailed impact analysis of the routine impacts of OCS activities associated with a CPA proposed action on live bottoms can be found in Chapters 4.2.1.6.1.2 and 4.2.1.6.2.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.6 of the WPA 233/CPA 231 Supplemental EIS. Below is a summary of that information.

The live bottoms (Pinnacle Trend and low-relief habitats) of the CPA could be adversely impacted by oil and gas activities resulting from a CPA proposed action in the absence of the proposed Live Bottom (Pinnacle Trend) Stipulation, which distances bottom-disturbing activity 30 m (100 ft) from pinnacles, and by case-by-case reviews of permit applications for wells, pipelines, and structure removals. There is a Live Bottom (Low Relief) Stipulation that is applied to leases in live bottom low-relief blocks with water depths of 100 m (328 ft) or less in the EPA and northeast corner of the CPA; however, none of these blocks are offered for lease in these proposed CPA lease sales; therefore, this stipulation will not be applied. BOEM's case-by-case reviews offer protection for live bottoms that occur outside of the identified live bottom low-relief blocks and do not permit bottom-disturbing activity within 30 m (100 ft) a live bottom.

Structure or pipeline emplacement and anchoring of pipeline barges, drilling rigs, and service vessels could damage Pinnacle features and low-relief live bottoms. Organisms on live bottoms could be crushed and hard features destroyed by bottom disturbance. Such habitat damage may take a long time to repopulate with live bottom communities. Distancing bottom-disturbing activity 30 m (100 ft) from live bottoms eliminated the possibility of placing a structure or anchor on a live bottom.

Oil and gas operations discharge cuttings with some adhered drilling mud that generates turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings near the Pinnacle Trend and low-relief areas would not greatly impact the biota of the live bottoms because the biota surrounding the live bottom features in or near the CPA are adapted to turbid (nepheloid) conditions and high sedimentation rates associated with the outflow of the Mississippi River (Gittings et al., 1992a). The pinnacles themselves and many live bottoms are coated with a veneer of sediment. Regional surface currents and water depth would largely dilute any oil- and gas-related effluent. Additional deposition and turbidity caused by a nearby well are not expected to adversely affect the live bottom habitat because such drilling muds and cuttings would be dispersed upon discharge. For example, 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, however, are limited to within 100-200 m (328-656 ft) of a well (Montagna and Harper, 1996; Kennicutt et al., 1996), and NPDES permit requirements limit discharge, limiting toxicity levels. The drilling of a well, therefore, would have minimal impacts on live bottom features due to distancing requirements and local turbidity levels.

The toxicity of produced waters has the potential to adversely impact the live bottom organisms; however, the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews would prevent the placement of oil and gas facilities within 30 m (100 ft) of a live bottom. In addition, the live bottom low-relief blocks are not currently for lease, and therefore, they will be distanced from discharges as well. Produced waters also rapidly disperse and remain in the surface layers of the water column, far above the live bottom features.

Platform removals have the potential to impact nearby habitats; however, the Live Bottom (Pinnacle Trend) Stipulation and BOEM’s case-by-case reviews before platform installation and removal prevent platforms from being placed within 30 m (100 ft) of any live bottom. This distancing requirement will separate sensitive low-relief habitats from blasts. Benthic organisms on live bottoms should also have limited impact because they are resistant to blasts, tolerant of turbidity, can physically remove some suspended sediment, and may be located above or be tall enough to withstand limited sediment deposition. Distancing would also help prevent live bottoms from being smothered by disturbed sediment as it settles out of the water column.

The Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews of permit applications would prevent most of the potential impacts on live bottoms from bottom-disturbing activities (structure emplacement, anchoring, and removal) and operational discharges associated with a CPA proposed action by distancing activities 30 m (100 ft) from live bottoms. The distancing requirement also allows for the dilution of operational discharges (drill cuttings and adhered muds as well as produced waters), and USEPA’s discharge regulations and permits limit toxicity of discharges. The natural turbidity of the environment also limits the impacts of suspended sediment and deposition on these habitats. Impacts on live bottom habitat as a result of OCS oil and gas operational discharges is, therefore, minimal.

Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of live bottoms of the CPA. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on live bottoms can be found in Chapters 4.2.1.6.1.3 and 4.2.1.6.2.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.6 of the WPA 233/CPA 231 Supplemental EIS. Without the Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews of permit applications, live bottoms could be impacted by accidental events. Live bottom features represent a small fraction of the continental shelf area in the CPA. The small portion of the seafloor covered by the Pinnacle Trend and the fact that low-relief 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 live bottoms.

The proposed Live Bottom (Pinnacle Trend) Stipulation (**Chapter 2.4.1.3.2**) and case-by-case reviews of permit applications would prevent most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of live bottoms by distancing activities that could result in oil spills and blowouts 30 m (100 ft) from the features. Also, note that none of the live bottom low-relief blocks are included in the area to be offered in a CPA proposed action. However, operations that occur in blocks adjacent to live bottom habitat may affect live bottom features.

In a subsurface spill or blowout situation, it would be expected that the majority of released oil would rise to the surface and that the most heavily oiled sediments would likely be deposited before reaching live bottom features. However, operations outside the buffer zones created by distancing activities from features could have some impact on live bottom features.

The depth below the sea surface to which many live bottom features rise helps to protect them from surface oil spills. Some Pinnacles may rise to within 40 m (130 ft) of the sea surface; however, many features have much less relief or are in deeper water depths. Any oil that might contact pinnacle features would probably be at low concentrations because the depth to which surface oil can mix down into the water column is less than the peak of the tallest pinnacles, and this would result in little effect to these features. Low-relief features are also far below the water's surface, except some in shallow EPA waters, and are far from any area available for lease. Because the concentration of oil becomes diluted as it physically mixes with the surrounding water and as it moves into the water column, any oil that might be driven to 10 m (33 ft) or deeper would probably be at concentrations low enough to reduce impact to these features. Any features in water shallower than 10 m (33 ft) would be located far from the source of activities in a CPA proposed action. Therefore, concentrated oil should not reach live bottom features, and any impacts from diluted oil would be sublethal.

A subsurface spill or plume may impact sessile biota of live bottom features. Oil or dispersed oil may cause sublethal impacts to benthic organisms if a plume reaches these features. Impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. The Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews of permit applications would limit the potential impact of such occurrences by keeping the sources of such adverse events geographically removed from the sensitive biological resources of live bottom features. Distancing OCS activity allows for oil to mix with the surrounding water and become less concentrated by the time it reaches a feature, thus reducing toxicity.

Suspended sediment and oil adhered to sediment in the water column as a result of a blowout may impact benthic organisms. However, because the Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews of permit applications distances petroleum-producing activity 30 m (100 ft) from live bottom features, the heaviest sediment concentrations would fall out of suspension and the suspended sediment would disperse, resulting in reduced turbidity and sedimentation near the sensitive features. Many of the live bottom organisms of the CPA are located within the influence of the Mississippi River plume and are more tolerant of turbidity and sedimentation, allowing them to withstand a degree of these impacts. Many also have the ability to rid themselves of sediment through ciliary action and mucus shedding.

The proposed Live Bottom (Pinnacle Trend) Stipulation, if applied, and case-by-case reviews of permit applications would assist in preventing most of the potential impacts on live bottom communities from blowouts, surface and subsurface oil spills, and the associated effects by increasing the distance of such events from the live bottoms. In addition, because no live bottom low-relief blocks are included in a CPA proposed action, most live bottom features are distanced from oil-producing activity. It would be expected that the majority of oil released from a blowout would rapidly rise to the surface and that the most heavily oiled sediments would likely be deposited on the seafloor before reaching the live bottoms. Any contact with spilled oil would likely cause sublethal effects to benthic organisms because the distance of activity would prevent contact with concentrated oil. In the unlikely event that oil from a spill would reach the biota of a live bottom, the effects would be primarily sublethal and impacts would be at the community level. Any turbidity, sedimentation, and oil adsorbed to sediments would also be at low concentrations by the time the live bottoms were reached, also resulting in sublethal impacts. Impacts from an oil spill on live bottoms are lessened by the distance of the spill to the features, the depth of the features, and the currents that surround the features. In the event that oil from a subsurface spill reached an area containing coral cover in lethal concentrations, the recovery could take in excess of 10 years (Fucik et al., 1984).

Summary and Conclusion

BOEM has reexamined the analysis for live bottoms presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for live bottoms presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The proposed Live Bottom (Pinnacle Trend) Stipulation is assumed to be in effect for this cumulative analysis as well as for the case-by-case reviews of permit applications to prevent impacts to identified live bottoms (low and high relief). Details on the Live Bottom (Pinnacle Trend) Stipulation can be found in Chapter 2.3.1.3.2 of this Supplemental EIS and in Chapter 2.4.1.3.2 of the 2012-2017 WPA/CPA Multisale EIS. The continued application of this proposed stipulation and case-by-case permit reviews would prevent any direct adverse impacts on the biota of the live bottoms, i.e., impacts potentially generated by oil and gas operations. The cumulative impact from routine oil and gas operations includes effects resulting from a CPA proposed action, as well as those resulting from past and future OCS oil and gas leasing. These operations include anchoring, structure emplacement, muds and cuttings discharge, effluent discharge, blowouts, oil spills, and structure removal. Potential non-OCS oil- and gas-related factors include vessel anchoring, import tankering, heavy storms and hurricanes, commercial fishing, and recreational scuba diving.

OCS Oil- and Gas-Related Impacts

Mechanical damage, such as anchoring, is considered to be a catastrophic threat to the biota of live bottoms. The continued application of the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews preclude anchoring on live bottoms by OCS 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 live bottoms (Lissner et al., 1991; Dinsdale and Harriott, 2004). The proposed Live Bottom (Pinnacle Trend) Stipulation restricts these activities within 30 m (100 ft) of a Pinnacle feature, thus preventing adverse impacts on benthic communities of these features. In addition, case-by-case reviews would identify live bottoms in the area of activity and prevent bottom-disturbing activity within 30 m (100 ft) of a live bottom.

The USEPA, through its NPDES discharge permit, enacts mitigating measures on discharges. Drilling fluids can be moderately toxic to marine organisms (the more toxic effluents are not allowed to be discharged under NPDES permits), but their effects are restricted to areas closest to the discharge point, thus preventing contact with the biota of live bottoms (Montagna and Harper, 1996; Kennicutt et al., 1996). Small amounts of drilling effluent in low concentrations may reach a live bottom from wells beyond the 30-m (100-ft) buffer; however, these amounts, if measurable, would be extremely small and would be restricted to small areas, with little effect on the biota.

The proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews of permit applications protect live bottom features by mandating a physical distance from drilling activities. Drilling fluid plumes are rapidly dispersed on the OCS; approximately 90 percent of the material discharged in drilling a well (cuttings and drilling fluid) settles rapidly to the seafloor, while 10 percent forms a plume of fine mud that drifts in the water column (Neff, 2005). Any drilling material that may reach coral can be removed by the coral using tentacles and mucus secretion, and it can be physically removed by currents that can help shed the mucus-trapped particles from the coral (Shinn et al., 1980; Hudson and Robbin, 1980).

With the inclusion of the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews, no discharges of effluents, including produced water, would take place within 30 m (100 ft) of a live bottom. This distancing, combined with USEPA’s discharge regulations and permits, should eliminate the threat of discharges reaching and affecting the biota of a live bottom. 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 a local scale, but no interference to the general ecosystem performance should occur.

Impacts on the live bottoms could occur as a result of OCS oil- and gas-related spills or spills from import tankering. Due to dilution and the depths of the crests of the Pinnacle and other live bottom features, discharges should not reach the live bottom features in sufficient concentrations to cause impacts. Tanker accidents would result in surface oil spills, which generally do not mix below a depth of 10-20 m (33-66 ft) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). The limited depth of mixing should protect most live bottoms, very few of which rise to within 20 m (66 ft) of the sea surface, except those in shallow waters of the EPA, which are extremely far from a CPA proposed action. Any dispersed surface oil from a tanker spill that may reach the benthic communities of live bottoms in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations would not be life threatening to larval or adult stages based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed or physically mixed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Potential blowouts and low-probability catastrophic spills (**Appendix B**) could impact the biota of the live bottoms. Based on the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews, few blowouts or low-probability catastrophic spills, if any, would reach the live bottoms. The proposed stipulation and BOEM's policy applied during case-by-case reviews creates a 30-m (100-ft) buffer zone around live bottoms; this buffer zone would protect the live bottoms from direct impacts by damaging amounts of suspended sediment from a seafloor blowout. Most of the oil from a seafloor blowout, even a catastrophic one, would rise to the surface, but some of it may be entrained in the water column as a subsea plume. Oil in a subsea plume could be carried to a live bottom. The resulting level of impacts depends on the concentration of the oil when it contacts the habitat. The farther the blowout is from the live bottom, the more dispersed the oil and sediment will become, reducing the possible impacts. If oil were to contact the live bottoms, the impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. In the highly unlikely event that oil from a subsurface spill could reach a coral-covered area in lethal concentrations, the recovery of this area could take in excess of 10 years (Fucik et al., 1984).

The cumulative impact of possible oil spills, along with the *Deepwater Horizon* explosion, oil spill, and response, is not anticipated to affect the overall live bottom habitat. The Live Bottom (Pinnacle Trend) Stipulation and case-by case reviews of permit applications would not allow wells to be drilled within 30 m (100 ft) of a live bottom, separating the habitat from the worst of the sediment deposition of a blowout and allowing most of the oil to rise to the sea surface without contacting live bottoms. If oil is released near a live bottom and concentrated or dispersed oil is entrained in the water column, it could contact nearby live bottom habitat with serious detrimental effects. Habitats receiving high concentrations of oil could take 10 or more years to recover (Fucik et al., 1984). However, since subsea plumes travel directionally with water currents, only live bottom habitats directly in the path of the plume would be affected. Therefore, the acute impacts of any large-scale blowout would likely be limited in scale, and any additive impacts of several blowouts should only impact small areas on an acute level, with possible sublethal impacts occurring over a larger area.

Platforms will be removed from the OCS Program each year; some may be in the vicinity of live bottoms (**Table 3-2**). However, the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case permit application reviews prevents the installation of platforms within 30 m (100 ft) of a live bottom, thus reducing the potential for impact from platform removal. The explosive removals of platforms are far enough away to prevent impacts to the biota of the live bottoms.

Non-OCS Oil- and Gas-Related Impacts

Although the Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews of permit applications prohibit oil and gas leaseholders from anchoring vessels and placing structures within 30 m (100 ft) of a live bottom, the policy does not affect other non-OCS oil- and gas-related activities such as fishing, recreational scuba diving, or anchoring other vessels on or near these features. Many of the live bottoms are well-known fishing and diving areas. Anchoring on a live bottom 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 (Lissner et al., 1991). Anchor damages incurred by benthic organisms may take more than 10 years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001).

Depending on the levels of fishing pressure exerted, recreational fishing activities that occur on live bottoms may impact local fish populations (refer to **Chapters 4.1.1.19 and 4.1.1.20**). The collecting activities by scuba divers on shallow live bottom features may have an adverse impact on the local biota. Much of the fishing on these habitats uses bottom fishing gear that may damage benthic organisms or may snag on the reefs and be lost. Such gear, particularly lines of varying thickness, can cut into the tissues of many benthic organisms during storm movement of bottom waters. Anchoring during recreational and fishing activities, however, would be the source of the majority of severe impacts incurred by the live bottoms.

Damage resulting from commercial fishing, especially bottom trawling, may have a severe impact on live bottoms. Bottom trawling in the Gulf of Mexico primarily targets shrimp from nearshore waters to depths of approximately 90 m (300 ft) (NRC, 2002). Although trawlers would not target areas with pinnacles or sharp relief as fishing ground, since outcrops may tangle with gear, accidental instances of trawling may occur near or over live bottoms, resulting in community damage. Reports indicate that bottom trawling activity on hard bottom substrates can overturn boulders and destroy epifaunal organisms (Freese et al., 1999). Large emergent sponges and anthozoans may be particularly vulnerable to trawling activity, as these organisms grow above the substrate and can be caught and removed by trawling activity (Freese et al., 1999). The recovery of corals and coralline algae may take decades to centuries and depends on the extent of the impact, frequency of disturbance, other natural changes that occur to the habitat, and the organism's life history (NRC, 2002).

Natural events such as storms, extreme weather, and fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms) may impact live bottom communities. Because of the depth of the Pinnacle Trend environment, waves seldom have a direct influence. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments (Brooks, 1991; CSA, 1992b). These forces are not expected to be strong enough to cause direct physical damage to organisms living on the features. Rather, currents are created by the wave action that can resuspend sediments to produce added turbidity and sedimentation (Brooks, 1991; CSA, 1992b). The animals in this region are well-adapted to the effects common to this frequently turbid environment (Gittings et al., 1992). Live bottom (low relief) communities, however, occur from the shoreline to 100 m (328 ft) of water and, because many of these features are located in shallow water, storm events may damage these environments. Currents are created by wave action that can resuspend sediments to produce added turbidity and sedimentation (Brooks, 1991; CSA, 1992b). Storms can physically affect shallow bottom environments, causing an increase in sedimentation, burial of organisms by sediment, a rapid change in salinity or dissolved oxygen levels, storm surge scouring, remobilization of contaminants in the sediment, and abrasion and clogging of gills as a result of turbidity (Engle et al., 2008). Storms have also been shown to uproot benthic organisms from the sediment (Dobbs and Vozarik, 1983), and breakage or detachment may occur as a result of storm activity (Yoshioka and Yoshioka, 1987). Such impacts may be devastating to a benthic community.

Hypoxic conditions of inconsistent intensities and ranges also occur annually in a band that stretches along the Louisiana-Texas shelf each summer (Rabalais et al., 2002a). The dissolved oxygen levels of bottom waters in the Gulf of Mexico hypoxic zone are less than 2 ppm during part of the summer season. Such low concentrations are lethal to many benthic organisms and may result in the loss of some benthic populations. Although this is mainly a character of the Louisiana-Texas shelf, its effect could reach some live bottom communities in the northeast portion of the CPA.

Summary and Conclusion

Activities causing mechanical disturbance represent the greatest threat to the live bottoms. This would, however, be prevented by the continued application of the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews. Potential OCS oil- and gas-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 Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews would preclude mechanical damage caused by oil and gas leaseholders from impacting the benthic communities of live bottoms and would protect them from operational discharges by establishing a 30-m (100-ft) buffer around the features. As such, little impact would be incurred by the biota of the live bottoms. The USEPA's discharge regulations and permits would further reduce discharge-related impacts.

Blowouts could potentially cause damage to benthic biota; however, due to the application of the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case permit application reviews, blowouts would not reach the live bottoms and associated biota in high concentrations, resulting in little impact on the features. If a subsea oil plume is formed, it could contact the habitats of a live bottom. The farther the oil source is from the live bottom, the more dilute and degraded the oil would be when it reaches the vicinity of the live bottom.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews would keep sources of OCS spills at least 30 m (100 ft) away from the immediate biota of the live bottoms. The majority of oil released below the sea surface would rise and should not physically contact organisms on live bottoms. In the unlikely event that oil from a subsurface spill would reach the biota of a live bottom, it would be physically or chemically dispersed to low concentrations by the time it reached the feature, and the effects would be primarily sublethal. In the very unlikely event that oil from a subsurface spill reached a live bottom in lethal concentrations, the recovery could take in excess of 10 years (Fucik et al., 1984). Finally, in the unlikely event a freighter, tanker, or other oceangoing vessel related to OCS Program activities or non-OCS oil- and gas-related activities sank and proceeded to collide with the live bottoms or associated habitat releasing its cargo and fuel, recovery could take years to decades, depending on the extent of the damage. Because these events are rare in occurrence, the potential of impacts from these events is considered low.

Non-OCS oil- and gas-related activities could mechanically disrupt the bottom (such as anchoring, as previously described). Natural events such as hurricanes or storms could cause severe impacts. Impacts from scuba diving, fishing, and discharges or spills from tankering of imported oil could have detrimental effects on live bottoms.

Overall, the incremental contribution of a CPA proposed action to the cumulative impact is negligible when evaluated against all other OCS oil- and gas-related and non-OCS oil- and gas-related impacts in the entire GOM. Where the proposed Live Bottom (Pinnacle Trend) Stipulation and case-by-case reviews are applied, mechanical impacts (anchoring and structure emplacement) and impacts from operational discharges (produced waters, drilling fluids, cuttings) or accidental discharges (oil spills, blowouts) would be removed from the immediate area surrounding the live bottoms. However, if the stipulation or reviews are not applied, acute long-term injury to live bottoms may occur as a result of a CPA proposed action.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources (NOAA's Gulf Spill Restoration Publications website, NOAA's Environmental Response Management Application [ERMA] Gulf Response website, NOAA's *Deepwater Horizon* Archive Publications and Factsheets, the Gulf of Mexico Sea Grant *Deepwater Horizon* Oil Spill Research and Monitoring Activities Database, the RestoreTheGulf.gov website, and the *Deepwater Horizon* Oil Spill Portal), as well as recently published journal articles and Federal documents was conducted to determine the availability of recent information on live bottoms. The search revealed new information on the monitoring of corals in the GOM for impacts of oil from the *Deepwater Horizon* explosion; information that is pertinent to this Supplemental EIS.

The NRDA has been investigating the possibility of impacts to mesophotic coral reefs in the Pinnacle Trend area as a result of the *Deepwater Horizon* explosion, oil spill, and response. Post oil-spill data (photos, video, and water quality collected by semipermeable membrane passive sampling devices) are being compared with pre-*Deepwater Horizon* data that exist from the Alabama Alps in the Pinnacle Trend (USDOC, NOAA, 2012a). The semipermeable membrane devices suggest that the Alabama Alps may have been exposed to petroleum hydrocarbons, but the pathway for impact by subsurface oil and dispersants has yet to be established. However, preliminary evidence indicates that planktivorous fish in the area have substantially decreased and mesophotic reef corals appear to be impacted (USDOC, NOAA, 2012a).

Toxicity tests conducted on larvae in the laboratory on two species of coral, *Porites astreoides* and *Montastraea faveolata*, indicated that the settlement and survival of coral larvae decreased with increasing water-accommodated fractions (WAF's) of *Macondo* oil, the dispersant COREXIT 9500, and WAF's of *Macondo* oil plus COREXIT 9500 (CEWAF) (Goodbody-Gringley et al., 2013). Note that these two species of coral are not found on live bottoms of the CPA (they are, however, found in the EPA and WPA) but that the results are shown as an example in oil impacts on coral settlement. The lethal concentration to 50 percent (LC_{50}) of the larval population for the WAF's of *Macondo* oil was 0.50 ppm and 0.51 ppm for *P. astreoides* and *M. faveolata*, respectively. The LC_{50} for COREXIT 9500 for *P. astreoides* and *M. faveolata* was 33.4 ppm and 19.7 ppm, while the CEWAF LC_{50} for these species was 1.84 ppm and 0.28 ppm, respectively (Goodbody-Gringley et al., 2013). It should be noted, however, that dispersants measured during the *Deepwater Horizon* explosion, oil spill, and response never reached chronic benchmarks in the water column (OSAT, 2010). In addition, one must be careful in using WAF to determine toxicity in an open system because it is based on a closed system reaching equilibrium with a contaminant, something that will not happen in the GOM. Therefore, the WAF and CEWAF may not be applicable for the GOM and could be considered a "worst-case scenario" if the entire GOM were to come into equilibrium with oil and dispersant inputs. Therefore, these laboratory-derived values do not accurately reflect field conditions.

In 2009, a petition was submitted to NMFS by the Center for Biological Diversity to list 83 additional species of coral under the ESA (Center for Biological Diversity, 2009). Those 83 "candidate species" were reviewed by NMFS. In April 2012, NMFS completed a Status Review Report and a Draft Management Report of the candidate species of corals, and on December 7, 2012, the "Proposed Listing Determinations for 82 Reef-Building Coral Species; Proposed Reclassification of *Acropora palmata* and *Acropora cervicornis* From Threatened to Endangered" was published in the *Federal Register* (*Federal Register*, 2012b). The NOAA determined that 12 of the petitioned species warranted listing as endangered (5 in the Caribbean and 7 in the Indo-pacific), 54 species warranted listing as threatened (2 in the Caribbean and 52 in the Indo-Pacific), and 16 did not warrant listing under the ESA. None of these corals are found on live bottoms in the CPA; however, they may be found on live bottoms in the EPA and on topographic features in the CPA and WPA. The public comment period was extended to April 6, 2013, and a public meeting was held on March 12, 2013 (*Federal Register*, 2013g). A final decision on the listing of these species has not been made at this time. If these proposed species are listed and if an action may affect the listed species or designated critical habitat, BOEM would consult with NMFS under section 7 of the ESA, as BOEM currently does for other listed species.

Limited data are currently available on the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response on the live bottoms in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to live bottoms. Relevant data on the status of live bottoms after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze. Much of these data are being developed through the NRDA process, which may take years to complete. Little data from the NRDA process have been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. In the place of this incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

4.1.1.7. Topographic Features

BOEM has reexamined the analysis for topographic features presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusions for topographic features presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.7 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from Chapter 4.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The potential routine impact-producing factors on topographic features of the CPA are anchoring, infrastructure emplacement, drilling effluent and produced-water discharges, and infrastructure removal.

These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features in the CPA. A detailed impact analysis of the routine impacts of OCS activities associated with a CPA proposed action on topographic features can be found in Chapter 4.2.1.7.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.7 of the WPA 233/CPA 231 Supplemental EIS.

The topographic features and associated coral reef biota of the CPA could be adversely impacted by oil and gas activities resulting from a CPA 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 CPA topographic features.

The No Activity Zone of the topographic features would be most susceptible to adverse impacts if oil and gas activities are unrestricted without the proposed Topographic Feature Stipulation. These impacting activities could include vessel anchoring and infrastructure emplacement; discharges of cuttings and adhered drilling mud, and produced water; 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 (Fucik et al., 1984; Rogers and Garrison, 2001). 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. Construction 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 the topographic features could cause turbidity and sedimentation that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the proposed 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 adhered drilling mud within the exclusion zones would 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 drill cuttings and adhered fluids during development operations would be a further source of impact to the sensitive biological resources of the topographic features. Therefore, in the absence of the proposed Topographic Features Stipulation, a CPA proposed action could cause significant long-term (10 years or more) adverse impacts to the biota of the topographic features (Fucik et al., 1984; Rogers and Garrison, 2001).

The Topographic Features Stipulation, if applied, would prevent most of the potential impacts on topographic features from bottom-disturbing activities (structure removal and emplacement) and operational discharges associated with a CPA proposed action through avoidance by requiring individual activities to be located at specified distances from the feature or zone. Because of the No Activity Zone requirement, permit restrictions, and the high-energy environment associated with topographic features, if any contaminants reach topographic features, they would be diluted from their original concentration, and impacts that do occur would be minimal.

Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features of the CPA. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on topographic can be found in Chapter 4.2.1.7.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.7 of the WPA 233/CPA 231 Supplemental EIS.

The topographic features and associated coral reef biota of the CPA could be damaged by oil and gas activities resulting from a CPA proposed action should they not be restricted by application of the proposed Topographic Features Stipulation. The impacting factors that could damage topographic features include blowouts, subsea oil spills, and surface oil spills, along with oil-spill response activities such as the use of dispersants.

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 if the proposed Topographic Features Stipulation is not applied. Direct oil contact may result in acute toxicity (Dodge et al., 1984;

Wyers et al., 1986). In most cases, recovery from disturbances would take 10 years or more (Fucik et al., 1984; Rogers and Garrison, 2001). The use of dispersants near or above protected features could result in impacts to the features because dispersants allow floating oil to mix with water. The decision to use dispersants near topographic features during an accidental event, however, lies with the Federal On-Scene Coordinator and is made on a case-by-case basis.

Disturbances, including oil spills and blowouts, could alter benthic substrates and their associated biota over large areas. 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. Accidental events related to a CPA proposed action could cause significant long-term (10 years or more) adverse impacts to the biota of the topographic features.

The proposed Topographic Features Stipulation, if applied, would assist in preventing most of the potential impacts on topographic feature communities from blowouts, surface, and subsurface oil spills and the associated effects by increasing the distance of such events from the topographic features. It would be expected that the majority of oil released from a blowout would rapidly rise to the surface and that the most heavily oiled sediments would likely be deposited on the seafloor before reaching the topographic features. Subsea oil would also be directed away from the more sensitive communities on the upper levels of topographic features because currents sweep around topographic features instead of over them (Rezak et al., 1983; McGrail, 1982). Due to distancing requirements of the Topographic Features Stipulation, any turbidity, sedimentation, and oil adsorbed to sediments would also be at low concentrations by the time the topographic features were reached, also resulting in sublethal impacts to benthic organisms.

In addition, any oil floating in surface waters from a blowout or tanker accidents as a result of OCS activity should have minimal impact on topographic features. Due to dilution with the surrounding water and the depths of the crests of the topographic features below the water's surface, surface floating oil should not reach topographic features in sufficient concentrations to cause impacts. Floating oil generally does not mix below a depth of 10-20 m (33-66 ft) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). The limited depth of mixing should protect most topographic features, very few of which rise to within 15 m (50 ft) of the sea surface. As a result, surface oil that may reach the benthic communities of topographic features in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations would not be life threatening to larval or adult stages based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed or physically mixed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984). Therefore, impacts from a surface or subsea oil spill on topographic features are lessened by the distance of the spill to the features, the depth of the features, and the currents that surround the features. In the event that oil from a subsurface spill reached an area containing coral cover in lethal concentrations, the recovery could take in excess of 10 years (Fucik et al., 1984).

Summary and Conclusion

BOEM has reexamined the analysis for topographic features presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for topographic features presented in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The proposed Topographic Features Stipulation is assumed to be in effect for this cumulative analysis. The continued application of this proposed stipulation would prevent any direct adverse impacts on the biota of the topographic features, i.e., impacts potentially generated by oil and gas operations. The cumulative impact from routine oil and gas operations includes effects resulting from a CPA proposed action, as well as those resulting from past and future OCS oil and gas leasing. These operations include anchoring, structure emplacement, muds and cuttings discharge, effluent discharge, blowouts, oil spills, and structure removal. Potential non-OCS oil- and gas-related factors include vessel anchoring, treasure-hunting activities, import tankering, heavy storms and hurricanes, the collapse of the tops of the topographic features due to dissolution of the underlying salt structure, commercial and recreational fishing, and recreational scuba diving.

OCS Oil- and Gas-Related Impacts

Mechanical damage, such as anchoring, is considered to be a catastrophic threat to the biota of topographic features. The continued application of the proposed Topographic Features Stipulation precludes anchoring on topographic features by OCS 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 (Rezak and Bright, 1979; Rezak et al., 1985). The proposed Topographic Features Stipulation restricts these activities within 152 m (500 ft) of the No Activity Zone around topographic features, thus preventing adverse impacts on benthic communities of topographic features (refer to NTL 2009-G39, "Biologically-Sensitive Underwater Features and Areas," **Chapter 2.3.1.3.1** of this Supplemental EIS, and Chapter 2.3.1.3.1. of the 2012-2017 WPA/CPA Multisale EIS).

The USEPA, through its NPDES discharge permit, enacts mitigating measures on discharges. As noted under routine events of a CPA proposed action, drilling fluids can be moderately toxic to marine organisms (the more toxic effluents are not allowed to be discharged under NPDES permits), and their effects are restricted to areas closest to the discharge point, thus preventing contact with the biota of topographic features (Montagna and Harper, 1996; Kennicutt et al., 1996). Small amounts of drilling effluent in low concentrations may reach a bank from wells outside the No Activity Zone; however, these amounts, if measurable, would be extremely small and would be restricted to small areas, with little effect on the biota.

The proposed Topographic Features Stipulation protects topographic features by mandating a physical distance from drilling activities. Drilling fluid plumes are rapidly dispersed on the OCS; approximately 90 percent of the material discharged in drilling a well (cuttings and adhered drilling fluid) settles rapidly to the seafloor, while 10 percent forms a plume of fine mud that drifts in the water column (Neff, 2005). The shunting of drilling muds and cutting is required for wells drilled in the vicinity of topographic features. Shunting restricts the cuttings to a smaller area and places the turbidity plume near the seafloor where the environment is frequently turbid and where benthic communities are adapted to high levels of turbidity. Water currents moving turbidity plumes across the seafloor would sweep around topographic features rather than carrying the turbidity over the banks (Bright and Rezak, 1978). Any sediment that may reach coral can be removed by the coral using tentacles and mucus secretion, and it can be physically removed by currents that can shed the mucus-trapped particles from the coral (Shinn et al., 1980; Hudson and Robbin, 1980).

With the inclusion of the proposed Topographic Features Stipulation, no discharges of effluents, including produced water, would take place within the No Activity Zone. Drill cuttings in areas around the No Activity Zone would be shunted to within 10 m (33 ft) of the seabed. This procedure, combined with USEPA's 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 a local scale, but no interference to the general ecosystem performance should occur.

Impacts on the topographic features could occur as a result of OCS oil- and gas-related spills or spills from tankering. Due to dilution and the depths of the crests of the topographic features, oil should not reach topographic features in sufficient concentrations to cause impacts. Tanker accidents would result in surface oil spills, which generally do not mix below a depth of 10-20 m (33-66 ft) (Lange, 1985;

McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). The limited depth of mixing should protect most topographic features, very few of which rise to within 15 m (50 ft) of the sea surface. Any dispersed surface oil from a tanker spill that may reach the benthic communities of topographic features in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations would not be life threatening to larval or adult stages based on experiments conducted with coral (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Knap, 1987; Wyers et al., 1986; Cohen et al., 1977) and observations after oil spills (Jackson et al., 1989; Guzmán et al., 1991). Any dispersed or physically mixed oil in the water column that comes in contact with corals, however, may evoke short-term negative responses by the organisms, such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Potential blowouts and low-probability catastrophic spills (**Appendix B**) could impact the biota of the topographic features. Based on the proposed Topographic Features Stipulation, few blowouts or low-probability catastrophic spills, if any, would reach the No Activity Zone around the topographic features. The proposed stipulation creates a buffer zone around the banks; this buffer zone would protect the banks from direct impacts from damaging amounts of suspended sediment from a seafloor blowout. Most of the oil from a seafloor blowout, even a catastrophic one, would rise to the surface, but some of it may be entrained in the water column as a subsea plume. Oil in a subsea plume could be carried to a topographic feature. The resulting level of impacts depends on the concentration of the oil when it contacts the habitat. The farther the blowout is from the topographic feature, the more dispersed the oil and sediment will become, reducing the possible impacts. Also, because currents sweep around topographic features instead of over them, subsea oil should be directed away from the more sensitive communities on the upper levels of topographic features (Rezak et al., 1983; McGrail, 1982). If oil were to contact the topographic features, the impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. In the highly unlikely event that oil from a subsurface spill could reach a coral-covered area in lethal concentrations, the recovery of this area could take in excess of 10 years (Fucik et al., 1984).

The cumulative impact of the *Deepwater Horizon* explosion, oil spill, and response on the topographic features of the CPA, if any, is anticipated to be small. The potential oiling footprint as reported through NOAA's Environmental Response Management Application (ERMA) posted on the GeoPlatform.gov website indicated that oil was recorded in surface waters of the CPA from approximately the western Louisiana border east to Panama City Florida (USDOC, NOAA, 2011d). Sackett Bank appeared to be the only bank beneath the oil slick, while only small surface patches of oil were reported in water near other banks. These small patches were discontinuous and scattered (USDOC, NOAA, 2011d). The crests of the topographic features, however, are deeper than the physical mixing ability of surface oil (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Rezak et al., 1983). Also, most of the oil that migrated west in the CPA, where most of the banks are located, was primarily observed close to Louisiana's Gulf Coast, farther inshore of the banks (USDOC, NOAA, 2011d). Based on the location of the surface oil, its mixing abilities, the depth of the features, and the trajectory of the dispersed subsea plume, most of the topographic features of the CPA should not have been impacted by oil from the *Deepwater Horizon*.

Water and sediment samples collected during and after the spill were analyzed as part of the OSAT (2010) report. A handful of samples collected off the Gulf Coast did reveal some PAH as a result of the *Deepwater Horizon* explosion, oil spill, and response; however, there were no exceedances of USEPA's aquatic life benchmarks measured near topographic features in either water or sediment (OSAT, 2010). There were six water samples out of 481 collected that exceeded USEPA's chronic toxicity benchmarks for PAH in the offshore waters (>3 nmi offshore to the 200-m [656-ft] bathymetric contour), all of which occurred within 1 m (3 ft) of the water surface (OSAT, 2010). There were 63 water samples out of 3,605 collected from deep water (>200 m; 656 ft) that exceeded USEPA's aquatic life benchmarks for PAH (OSAT, 2010). Exceedances occurred near the water surface or in the deepwater plume within 70 km (44 mi) of the well. Oil detected in the subsurface plume was between 1,100 and 1,300 m (3,609 and 4,265 ft) and moving southwest along those depth contours (OSAT, 2010), which is deeper than the topographic features. No sediment samples collected offshore (>3 nmi offshore to the 200-m [656-ft] depth contour) and seven sediment samples collected in deep water (>200 m; 656 ft) exceeded USEPA's aquatic life benchmarks for PAH exposure (OSAT, 2010). All chronic aquatic life benchmark exceedances in the sediment occurred within 3 km (2 mi) of the well, and samples fell to background levels at a distance of 10 km (6 mi) from the well (OSAT, 2010). Dispersants were also detected in waters off Louisiana, but they were below USEPA's benchmarks of chronic toxicity. No dispersants were detected in sediment on the Gulf floor (OSAT, 2010). Topographic features in the CPA, therefore, are not expected to be impacted by PAH in the water column or sediment, as they are located much farther from the well than measured benchmark exceedances.

In addition, post oil-spill data (photos, video, water quality collected by semipermeable membrane passive sampling devices, sediment, and tissue samples) collected in the CPA (Sonnier Bank) are being compared with data that exist from coral reef monitoring programs to quantify the loss of corals, the loss of coral community components, and the loss of ecological services provided by the coral communities. There has been no documented evidence of *Macondo* oil, dispersants, or disruption from the response activities (USDOC, NOAA, 2012a). Based on the distance of the banks in the CPA from the *Macondo* well, the fact that much of the oil was closer inshore than the banks, the crests of the banks are deeper than the surface oil mixing capabilities, the measured PAH were below USEPA's chronic aquatic life benchmarks and detection was far from any topographic feature, and the fact that data collected at a bank in the CPA did not show evidence of oil or dispersants reaching these features, it is not expected that any additional information released as part of the NRDA process following the *Deepwater Horizon* explosion, oil spill, and response would impact BOEM's analysis of topographic features in the CPA or the potential incremental impact on these features. This information, therefore, is not essential to a reasoned choice among the alternatives analyzed in this Supplemental EIS.

Platforms will be removed from the OCS Program each year; some may be in the vicinity of topographic features (**Table 3-2**). However, the proposed Topographic Features Stipulation prevents the installation of platforms near the No Activity Zone, thus reducing the potential for impact from platform removal. The explosive removals of platforms are far enough away to prevent impacts to the biota of the topographic features.

Non-OCS Oil- and Gas-Related Impacts

Although the Topographic Features Stipulation prohibits oil and gas leaseholders from anchoring vessels and placing structures within 152 m (500 ft) of the No Activity Zone around topographic features, the stipulation does not affect other non-OCS oil- and gas-related activities such as fishing, recreational scuba diving, or anchoring other vessels on or near these features. Many of the topographic features are found near established shipping fairways and are well-known fishing areas. The Flower Garden Banks National Marine Sanctuary allows conventional hook and line fishing within the boundaries of the Sanctuary, which includes Stetson Bank (USDOC, NOAA, 2010a). Also, the Flower Garden Banks and several of the shallower topographic features are frequently visited by scuba divers aboard recreational vessels (Hickerson et al., 2008). 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 (Lissner et al., 1991). Anchor damages incurred by benthic organisms may take more than 10 years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). The Flower Garden Banks National Marine Sanctuary prohibits all anchoring within its boundaries and has installed numerous mooring buoys at the East and West Flower Garden Banks and Stetson Bank to support recreational activities (USDOC, NOAA, 2010a).

The use of explosives in treasure-hunting operations has become a concern on topographic features. Several large holes and serious damage has occurred on Bright Bank, and treasure hunters have damaged the bank as recently as 2001; both of these have resulted in the loss of coral cover (Schmahl and Hickerson, 2006). The recovery from such destructive activity may take in excess of 10 years and would depend on the type and extent of damage incurred by individual features (Fucik et al., 1984; Rogers and Garrison, 2001). This activity is not governed by BOEM or NOAA, and it could impact topographic features in the Gulf of Mexico.

Impacts from natural occurrences such as hurricanes occasionally result in damage to the biota of the topographic features. Hurricane Rita caused severe damage to Sonnier Bank in the CPA (Robbart et al., 2009). Live cover was reduced at this bank and the disappearance of the sponge colonies, *Xestospongia muta*, was notable (Robbart et al., 2009). The community structure had visibly changed from pre-Hurricane Rita (2004) studies at this bank (Kraus et al., 2006 and 2007). In 2006, the habitat was dominated by algae, indicating an alteration in habitat after Hurricane Rita (Kraus et al., 2007). The algal cover, however, was the beginning of recovery of the storm-impacted areas, which was further colonized with sponges (Robbart et al., 2009). Fish community shifts were also observed on Sonnier Bank after Hurricane Rita versus before the storm, but clear links have yet to be made to the storm (Kraus et al., 2007). Hurricane Rita also impacted the Flower Garden Banks in the WPA. Surveys at East Flower Garden Bank indicated that 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 (Hickerson et al., 2008; Hickerson and Schmahl, 2007; Robbart et al., 2009). Hurricane Katrina may have caused similar damage on other topographic features in both the CPA and WPA. Another possible natural impact to the banks would be the dissolution of the underlying salt structure, leading to collapse of the reef (Seni and Jackson, 1983). Dissolution of these salt structures is unlikely and beyond regulation abilities.

Depending on the levels of fishing pressure exerted, recreational and commercial fishing activities that occur at the topographic features may impact local fish populations. Note that only hook and line fishing for both recreational and commercial fishers is permitted within the Flower Garden Banks National Marine Sanctuary (East Flower Garden Bank, West Flower Garden Bank, and Stetson Bank). In addition, 13 reefs in the GOM (Stetson, East Flower Garden, West Flower Garden, 29 Fathom, MacNeil, Rankin, McGrail, Geyer, Sonnier, Bouma, Rezak, Alderdice, and Jakkula Banks) have been identified as Habitat Areas of Particular Concern (HAPC's) and measures to prohibit bottom anchoring at the reefs, trawling gear, bottom long lines, buoy gear, and fish traps in some HAPC's have been included in fishery management plans of particular HAPC's (Hickerson et al., 2008). Although certain fishing gears may not be prohibited on other banks, mobile gears that disturb the bottom, such as bottom trawls, would probably not be used on top of banks because nets can get caught on the features, resulting in snags and tears to the gear. The collecting activities by scuba divers on shallow topographic features may also have an adverse impact on the local biota. Collecting is prohibited at the Flower Garden Banks National Marine Sanctuary (USDOC, NOAA, 2010a). However, anchoring associated with diving and fishing activities would be the source of the majority of severe impacts incurred by the topographic features. BOEM does not regulate any of these activities, and these activities could impact topographic features in the Gulf of Mexico.

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 proposed Topographic Features Stipulation. Potential OCS oil- and gas-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 prevent mechanical damage caused by oil and gas leaseholders from impacting the benthic communities of the topographic features and would protect them from operational discharges by establishing a buffer around the features. As such, little impact would be incurred by the biota of the topographic features. The USEPA's discharge regulations and permits would further reduce discharge-related impacts.

Blowouts and subsea spills could potentially cause damage to benthic biota; however, due to the application of the proposed Topographic Features Stipulation distancing OCS activity and sources of spills at least 152 m (500 ft) from the No Activity Zone surrounding topographic features, concentrated oil would not reach the biota on topographic features, resulting in little impact on the features. The majority of oil released below the sea surface would rise and should not physically contact organisms on topographic features inside a No Activity Zone. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, it would be physically or chemically dispersed to low concentrations by the time it reached the feature, and the effects would be primarily sublethal. In addition, prevailing currents swept around the banks, which would direct oil in the water column around features, not onto them

Surface spills would also have little impact on topographic features. The application of the Topographic Features Stipulation would distance oil and gas activity from the topographic features, allowing surface oil to mix with surrounding water and diluting it as it travels from the source. Also, surface oil would not mix to the depth of the crests of most topographic features, and any oil that could mix to the shallower crests would be diluted below concentration known to cause acute impacts to corals.

The farther the oil source is from the bank, the more dilute and degraded the oil would be if it reaches the vicinity of the topographic features.

In the unlikely event a freighter, tanker, or other oceangoing vessel related to OCS Program activities or non-OCS oil- and gas-related activities sank and proceeded to collide with the topographic features or associated habitat releasing its cargo and fuel, recovery could take years to decades, depending on the extent of the damage. Because these events are rare in occurrence, the potential of impacts from these events is considered low.

Non-OCS oil- and gas-related activities could mechanically disrupt the bottom (such as anchoring, bottom-disturbing mobile fishing gear, and treasure-hunting activities). 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 impact a single feature. Impacts from scuba diving, fishing, and discharges or spills from tankering of imported oil not related to the OCS Program could have detrimental effects on topographic features, especially because the stipulations that BOEM applies to OCS oil and gas activities are not applied to non-OCS oil and gas activities and, therefore, cannot require the distancing of all activity from the features.

Overall, the incremental contribution of a CPA proposed action to the cumulative impact is negligible when evaluated against all other OCS oil- and gas-related and non-OCS oil- and gas-related impacts in the entire GOM. Where the proposed Topographic Features Stipulation is applied, mechanical impacts (anchoring and structure emplacement) and impacts from operational discharges (produced waters, drilling fluids, cuttings) or accidental discharges (oil spills, blowouts) would be removed from the immediate area surrounding the topographic features. However, if the stipulation is not applied, acute long-term injury to topographic features may occur as a result of a CPA proposed action.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources (NOAA's Gulf Spill Restoration Publications website, NOAA's Environmental Response Management Application [ERMA] Gulf Response website, NOAA's *Deepwater Horizon* Archive Publications and Factsheets, the Gulf of Mexico Sea Grant *Deepwater Horizon* Oil Spill Research and Monitoring Activities Database, the RestoreTheGulf.gov website, and the *Deepwater Horizon* Oil Spill Portal), as well as recently published journal articles and Federal documents was conducted to determine the availability of recent information on topographic features. The search revealed new information on monitoring of corals in the GOM for impacts of oil from the *Deepwater Horizon* explosion and on the proposed threatened/endangered listing of coral species in the GOM; information that is pertinent to this Supplemental EIS.

The NRDA has been investigating the possibility of impacts to shallow-water corals from Texas to Florida in the Gulf of Mexico and around to the Atlantic Coast of Florida, following the Florida Reef Tract, as a result of the *Deepwater Horizon* explosion, oil spill, and response. Post oil-spill data (photos, video, water quality collected by semipermeable membrane passive sampling devices, sediment, and tissue samples) are being compared with data that exist from continuous monitoring at previously monitored sites (USDOC, NOAA, 2012a). The goal is to quantify the loss of corals, the loss of coral community components, and the loss of ecological services provided by the coral communities. There has been no documented evidence of *Macondo* oil, dispersants, or disruption from the response activities within the areas of the CPA that were sampled, specifically Sonnier Bank (USDOC, NOAA, 2012a).

Toxicity tests conducted on larvae in the laboratory on two species of coral, *Porites astreoides* and *Montastraea faveolata*, indicated that the settlement and survival of coral larvae decreased with increasing WAF's of *Macondo* oil, the dispersant COREXIT 9500, and WAF's of *Macondo* oil plus COREXIT 9500 (Goodbody-Gringley et al., 2013). Note that these two species of coral are not found in banks of the CPA (they are found in the WPA), but that the results are shown as an example in oil impacts on coral settlement. The lethal concentration to 50 percent (LC_{50}) of the larval population for the WAF's of *Macondo* oil was 0.50 ppm and 0.51 ppm for *P. astreoides* and *M. faveolata*, respectively. The LC_{50} for COREXIT 9500 for *P. astreoides* and *M. faveolata* was 33.4 ppm and 19.7 ppm, while the WAF's of *Macondo* oil plus COREXIT 9500 LC_{50} for these species was 1.84 ppm and 0.28 ppm, respectively (Goodbody-Gringley et al., 2013). It should be noted, however, that dispersants measured during the *Deepwater Horizon* explosion, oil spill, and response never reached chronic benchmarks in the water column (OSAT, 2010). In addition, one must be careful in using WAF's to determine toxicity in an open system because it is based on a closed system reaching equilibrium with a contaminant, something that will not happen in the GOM. Therefore, the WAF's of *Macondo* oil and WAF's of *Macondo* oil plus COREXIT 9500 may not be applicable for the GOM and could be considered a "worst-case scenario" if the entire GOM were to come into equilibrium with oil and dispersant inputs. Therefore, these laboratory derived values do not accurately reflect field conditions.

In 2009, a petition was submitted to NMFS by the Center for Biological Diversity to list 83 additional species of coral under the ESA (Center for Biological Diversity, 2009). Those 83 "candidate species" were reviewed by NMFS. In April 2012, NMFS completed a Status Review Report and a Draft Management Report of the candidate species of corals, and on December 7, 2012, the "Proposed Listing Determinations for 82 Reef-Building Coral Species; Proposed Reclassification of *Acropora palmata* and *Acropora cervicornis* from Threatened to Endangered" was published in the *Federal Register* (*Federal Register*, 2012b). The NOAA determined that 12 of the petitioned species warranted listing as endangered (5 in the Caribbean and 7 in the Indo-pacific), 54 species warranted listing as threatened (2 in the Caribbean and 52 in the Indo-Pacific), and 16 did not warrant listing under the ESA. The coral found in the CPA (on McGrail Bank) proposed for listing as threatened is *Agaricia lamarcki*. The public comment period was extended to April 6, 2013, and a public meeting was held on March 12, 2013 (*Federal Register*, 2013g). A final decision on the listing of these species has not been made at this time. If these proposed species are listed, then BOEM would consult with NMFS under Section 7 of the ESA if an action may affect the listed species or designated critical habitat, as BOEM currently does for other listed species.

Limited data are currently available on potential impacts of the *Deepwater Horizon* explosion, oil spill, and response on the topographic features in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to topographic features. Relevant data on the status of topographic features after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze. Much of these data are being developed through the NRDA process, which may take years to complete. Little data from the NRDA process have been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. In the place of this incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

4.1.1.8. Sargassum *Communities*

BOEM has reexamined the analysis for *Sargassum* communities presented in the 2012-2017 WPA/CPA Multisale EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for *Sargassum* communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sale 235, 241, and 247.

A detailed description of *Sargassum* communities and full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.8 the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.8 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description and impact analyses incorporated from the 2012-2017 WPA/CPA Multisale EIS and the updated information provided in the WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since the documents were published is presented below.

Sargassum is one of the most ecologically important brown algal genera found in the pelagic environment of tropical and subtropical regions of the world. The pelagic complex in the GOM is mainly comprised of *S. natans* and *S. fluitans* (Lee and Moser, 1998; Stoner, 1983; Littler and Littler, 2000). Both species of *Sargassum* live immediately below the water surface and are fully adapted to a pelagic existence (Lee and Moser, 1998). These floating plants may be up to a few meters in length and may be found floating alone or in larger rafts or mats that support communities of fish and a variety of other marine organisms. The distribution, size, and abundance of *Sargassum* mats varies depending on environmental and physiochemical factors such as temperature, salinity, and dissolved oxygen.

Impacts of Routine and Accidental Events

Impact-producing factors associated with routine events for a CPA proposed action that could affect *Sargassum* may include the following: (1) drilling discharges (muds and cuttings); (2) produced water and well treatment chemicals; (3) operational discharges (deck drainage, sanitary and domestic water, bilge and ballast water); and (4) physical disturbance from vessel traffic and the presence of exploration and production structures (i.e., rigs, platforms, and MODU's). A detailed impact analysis of the routine impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on *Sargassum* communities can be found in Chapter 4.2.1.8.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.8 of the WPA 233/CPA 231 Supplemental EIS.

Sargassum, is a widely distributed pelagic algae that is ubiquitous in the northwestern Gulf and seasonal throughout the central and eastern Gulf and northwest Atlantic. Considering its widespread distribution and occurrence in the upper water column near the sea surface, it may be contacted by routine discharges from oil and gas operations. All routine discharges, including drilling discharges, produced water, and operational discharges (e.g., deck runoff, bilge water, sanitary effluent, etc.) could potentially contact *Sargassum*. However, the quantity and volume of these discharges is relatively small compared with the surface area of pelagic waters of the CPA (268,922 km^2; 103,831 mi^2). Therefore, although discharges would contact *Sargassum*, potentially transferring contaminants to *Sargassum*, they would only contact a very small portion of the *Sargassum* population. Because these discharges are highly regulated to control toxicity and because they would continue to be diluted in the Gulf water, reducing concentrations of any toxic component, produced-water impacts on *Sargassum* would be minimal.

The impingement by service vessels, working platforms, and drillships would contact only a very small portion of the *Sargassum* population. For those plants coming in contact with OCS equipment, the result may be the physical destruction of the plant or the stranding and subsequent desiccation of the plant. The impacts to *Sargassum* that are associated with a CPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community as a whole and would be resilient to the minor effects predicted. *Sargassum* has a yearly cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community.

Impact-producing factors associated with accidental events for a CPA proposed action that could affect *Sargassum* and its associated communities include (1) spills (i.e., surface oil, fuel spills, and underwater well blowouts), (2) spill-response activities, and (3) chemical spills. These impacting factors would have varied effects depending on the intensity of the spill and the presence of *Sargassum* in the area of the spill. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on *Sargassum* communities can be found in Chapter 4.2.1.8.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.8 of the WPA 233/CPA 231 Supplemental EIS.

All types of spills, including surface oil and fuel spills, underwater well blowouts, and chemical spills, could potentially contact *Sargassum*. The quantity and volume of most of these spills would be relatively small compared with the surface waters of the CPA (268,922 km^2; 103,831 mi^2). Therefore, most spills would only contact a very small portion of the *Sargassum* population. Accidental spills would be diluted by the Gulf water and, therefore, concentrations of toxic components that could potentially contaminate or kill *Sargassum* tissues would also be reduced in this scenario. The impacts to *Sargassum* that are associated with a CPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community unless a low-probability catastrophic spill occurs (**Appendix B**). In the case of a very large spill, the *Sargassum* algae community could result in the death of a large number of plants across a geographically large area in the northern Gulf of Mexico. The *Sargassum* community lives in pelagic waters with generally high water quality and is expected to show good resilience to the predicted effects of spills. It has a yearly growth cycle that promotes quick recovery from impacts and that would be expected to restore typical population levels in 1-2 growing seasons.

Summary and Conclusion

BOEM has reexamined the analysis for *Sargassum* communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. Although important, no new or significant information was discovered to change the conclusions reached that activities associated with the proposed OCS activity will not significantly impact *Sargassum* communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

Cumulative impacts from OCS oil- and gas-related operations include effects resulting from a CPA proposed action, as well as those resulting from past and future OCS leasing. These operations include drilling discharges, produced water and well treatment chemicals, operational discharges, and physical disturbance from OCS oil- and gas-related vessels and structures. Potential non-OCS oil- and gas-related factors include hurricanes, water quality, and non-OCS vessel traffic. For additional information on the potential cumulative impacts to *Sargassum* communities, refer to Chapter 4.2.1.8.4 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.8 of the WPA 233/CPA 231 Supplemental EIS, which are hereby incorporated by reference.

OCS Oil- and Gas-Related Impacts

Pelagic *Sargassum* floats near the surface in oceanic waters and is moved by surface currents throughout the GOM. It can be found from scattered clumps to large mats. Vessel passage and stationary structures can have minor physical impacts on *Sargassum*. Vessels transiting the GOM pass through *Sargassum* mats, producing slight impacts to the *Sargassum* community by breaking up clumps/mats or physically destroying the plant. None of these would have more than minor localized effects to the affected mats as these mats routinely break up. Oil and gas structures can alter the movement of *Sargassum* mats and entrap small quantities of the algae. This is expected to be a minor impact with minimal consequences to the overall *Sargassum* community.

The discharge of drill cuttings with small quantities of associated drilling muds from oil and gas drilling can result in impacts to the *Sargassum* community, including contamination of the plant tissue by metals and chemicals contained within the discharges. Most cuttings from well drilling are discharged from the drill platform at the sea surface. This creates an area of high turbidity in the vicinity of drill operations, but the cuttings are typically deposited on the seafloor within 1,000 m (3,280 ft) of the discharge location. Some fine components of the plume may travel farther but they are dispersed in low concentrations throughout the water column (CSA, 2004; NRC, 1983). Exposure of *Sargassum* to discharges would be minimal as the composition of the discharges are limited by NPDES regulations to ensure that toxicity levels are low. These effects would be localized to small portions of *Sargassum* and represent a negligible amount of the incremental impact to *Sargassum* communities.

Effluents from marine vessels of all types and from oil and gas platforms and drillships can affect *Sargassum*. Runoff water from the decks of ships and platforms may contain small quantities of oil, metals, and other contaminants. Larger vessels and offshore platforms discharge effluents from sanitary facilities (gray water). They also circulate seawater to cool the ships' engines, electric generators, and other machines. The cooling water discharge may be up to 11°C (20°F) warmer than the surrounding seawater (USDHS, CG, and USDOT, MARAD, 2003; Patrick et al., 1993). This temperature difference can accumulate in the vicinity of the discharge. For ships, this would only occur when the vessel is stationary. For oil and gas platforms, drillships, and offshore LNG terminals, localized warming of the water could occur (Emery et al., 1997; USDHS, CG, and USDOT, MARAD, 2003). However, the warm water is rapidly diluted, mixing to background temperature levels within 100 m (328 ft) of the source (USDHS, CG, and USDOT, MARAD, 2003). Effects from gray water, deck runoff, and cooling water are only notable for stationary locations. Produced waters from stationary locations are rapidly diluted and impacts are only observed within 100 m (328 ft) of the discharge point (Neff and Sauer, 1991; Trefry et al., 1995; Gittings et al., 1992b). Effluent discharges are also limited by NPDES regulations. The effects are localized, with only brief contact to passing *Sargassum* before dilution to background levels. The effect on plants or animals could be the contamination of tissues by toxins that could result in an increase in physiological stress while processing the contaminants. These effects would comprise a negligible portion of the overall cumulative impact to *Sargassum* communities.

Accidental spills of oil and other chemicals could affect *Sargassum* and its community wherever they contact the algae. Small spills would have a limited local effect on a small portion of the *Sargassum* community. Short-term exposure of passing *Sargassum* to high concentrations of oil and chemicals could result in death and the sinking of algae and organisms contacted. The size of the overall effect on *Sargassum* would depend on the size of the spill and the success of spill-response efforts. A low-probability catastrophic spill, which is not reasonably expected and not part of a CPA proposed action, such as the *Deepwater Horizon* oil spill, could have noticeable impacts to the overall *Sargassum* community (**Appendix B**). These impacts could destroy a sizable portion of *Sargassum* habitat wherever the surface slick of oil travels. The effects could reduce the supply of algae transiting from the GOM to the Atlantic. This effect, although large, would contact only a portion of the algae in the region of the spill. *Sargassum* algae are a widespread habitat with patchy distribution across the northern GOM and the western Atlantic. Due to the vegetative production of *Sargassum* algae, the community would likely recover within 1-2 seasons (1-2 years). If such a spill does occur, it would account for a sizable portion of the cumulative impact that affects *Sargassum*, although even such an impact would affect only a portion of the *Sargassum* in the region of its occurrence.

Turbulence from wakes and direct damage from propellers on vessels servicing OCS activities could affect *Sargassum* by breaking up mats or destroying strands. However, the amount of damage that vessels could inflict on a *Sargassum* mat would be minimized because of *Sargassum*'s temporary nature. *Sargassum* mats are naturally loose knit with the ability to break apart and reform. Any vessel-related damage would likely be seen in the community of organisms inhabiting these mats, which may be killed when being struck by a vessel. Sea turtles and small fishes that reside in (rather than below) *Sargassum* mats would be most susceptible to this type of damage. However, the foot print of any vessel in the CPA is small compared with the distribution of *Sargassum*, and its transitory life history minimizes the possibility that any mat or the inhabitants are routinely affected. Because the proposed activity is not expected to substantially increase (if any) the number of OCS oil- and gas-related vessels, it is likely that OCS activities will only have a minimum and local effect on the *Sargassum* community.

Non-OCS Oil- and Gas-Related Impacts

Hurricanes are major natural sources of impacts that affect the *Sargassum*. The energy associated with these storms can break up mats, destroy strands, and displace animals; however, the life history and the widespread distribution of *Sargassum* communities minimizes the probability that any given storm will have any lasting population-level effects. Violent surface turbulence caused by these storms would dislocate many of the organisms living on and in the *Sargassum*. Some of the organisms (those that cannot swim or swim only weakly) such as nudibranchs (sea slugs), shrimp, *Sargassum* fish (*Histrio histrio*), and pipefish (*Syngnathus* spp.) would become separated from the algae. Without cover, many would fall prey to fish after a storm; others may sink to the seafloor and die. Some epifauna, such as hydroids, living on the algae may suffer physical damage or be broken off. Hurricanes can also drive *Sargassum* into waters less conducive for growth and can strand large quantities on beaches. In addition, *Sargassum* communities may be susceptible to nonpoint source pollution from land-based runoffs carrying pollutants and excessive nutrients, especially in nearshore areas. The results could be a basinwide reduction in *Sargassum* biomass. Turbulence from wakes, direct damage from propellers, impingement on non-OCS vessels (i.e., commercial shipping, fishing activity, and pleasure boating) could also affect *Sargassum* by breaking up mats, destroying plants, or stranding plants. However, the amount of damage that vessels could inflict on a *Sargassum* mat would be minimized because of *Sargassum*'s transitory nature. *Sargassum* mats are naturally loose knit with the ability to break apart and reform. Any vessel-related damage would likely be seen in the community of organisms inhabiting these mats, which may be killed by being struck by a vessel. Sea turtles and small fishes that reside in (rather than below) *Sargassum* mats would be most susceptible to this type of damage. Compared with the OCS, the number of vessels involved in fishing activities, pleasure boating, and commercial shipping activities far exceeds the number of OCS oil- and gas-related vessels.

Summary and Conclusion

Because of the temporary nature and widespread distribution of *Sargassum* communities, the cumulative effects of all OCS oil- and gas-related and non-OCS oil- and gas-related impacts associated with a CPA proposed action would have a localized and short-term effect. *Sargassum* occurs seasonally in almost every part of the northern GOM, resulting in a wide distribution over a very large area. However, its occurrence is patchy, drifting in floating mats that are occasionally impinged on ships and on oil and gas structures. This large, scattered, patchy distribution results in only a small portion of the total community contacting OCS oil- and gas-related ships, structures, or drilling discharges. Contact with drilling discharges and discharges of effluent from ships' operations also results in only short-term, localized effects. Because discharges are highly regulated to limit toxicity and because they would continue to be diluted in the GOM waters, concentrations of any toxic components related to a CPA proposed action would be limited. In the event that a low-probability catastrophic spill, which is not reasonably expected and not part of a CPA proposed action, would occur, *Sargassum* and its associated inhabitants in that area are expected to suffer mortality (**Appendix B**). However, *Sargassum* is highly resilient and recovery is expected within 1-2 growing seasons. The incremental contribution of a CPA proposed action to the overall cumulative impacts on *Sargassum* communities that would result from the OCS Program, when compared with environmental factors (such as hurricanes and coastal water quality), and non-OCS oil- and gas-related activities (such as non-OCS oil- and gas-related vessel traffic), is expected to be minimal.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search was conducted for new information published since the publication of the 2012-2017 WPA/CPA Multisale EIS. A search of Internet information sources, including scientific journals, published information from universities and research institutes, and governmental resource agencies, was conducted to determine the availability of new information. One of the primary publications relevant to this Supplemental EIS is the identification of the northwest Gulf of Mexico and the area near the mouth of the Amazon River as "nursery areas" for *Sargassum* in the Sargasso Sea. Estimates suggest that between 0.6 and 6 million tonnes of *Sargassum* are present annually in the Gulf of Mexico, with an additional 100 million metric tons exported to the Atlantic basin (Gower and King, 2008, Gower and King 2011, Gower et al. 2013). In addition, Rooker et al. (2012) quantified the use of *Sargassum* by billfishes in the Gulf of Mexico and concluded that the *Sargassum* biomass was not a suitable habitat for most juvenile billfishes because it can concentrate predators.

There remains incomplete or unavailable information on the effects of the *Deepwater Horizon* explosion, oil spill, and response on *Sargassum* that may be relevant to reasonably foreseeable significant adverse impacts. What scientifically credible information is available has been applied by BOEM's subject-matter experts using accepted scientific methodologies. Samples and results developed as part of the NRDA process have not been released and there is no timeline for this information becoming available. Nevertheless, BOEM has determined that this incomplete or unavailable information is not essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because *Sargassum* is widely distributed throughout the Gulf and the yearly cycle of replenishment for *Sargassum* indicates that impacts from the *Deepwater Horizon* explosion, oil spill, and response would be significantly reduced or eliminated within a year or two.

4.1.1.9. Chemosynthetic Deepwater Benthic Communities

BOEM has reexamined the analysis for chemosynthetic deepwater benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for chemosynthetic deepwater benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.9 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.9 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS and the updated information provided in the WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The potential routine impact-producing factors on chemosynthetic deepwater benthic communities of the CPA are bottom-disturbing activities associated with anchoring, structure emplacement, pipelaying, structure removal, and discharges of drill cuttings, muds, and produced water. Analysis of the routine impacts of OCS activities associated with a CPA proposed action on chemosynthetic deepwater benthic communities can be found in Chapter 4.2.1.9.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.9 of the WPA 233/CPA 231 Supplemental EIS.

Considerable mechanical damage could be inflicted upon deepwater chemosynthetic communities by routine OCS drilling activities associated with a CPA proposed action if mitigations are not applied. Bottom-disturbing activities associated with anchoring, structure emplacement, pipelaying, and structure removal cause localized bottom disturbances and disruption of benthic communities in the immediate area. Routine discharge of drill cuttings with associated muds can also affect the seafloor. Without mitigating measures, these activities could result in smothering by the suspension of sediments or the crushing of organisms residing in these communities. Because of the avoidance guidance provided in NTL 2009-G40, "Deepwater Benthic Communities," the risk of these physical impacts are greatly reduced by requiring the avoidance of potential chemosynthetic communities. Discharges of produced waters on the sea surface, chemical spills, and deck runoff would be diluted in surface waters, having no effect on seafloor habitats. Impacts from bottom-disturbing activities directly on chemosynthetic communities are expected to be extremely rare because of the application of required protective measures as guidance provided by NTL 2009-G40. Information included in required hazards surveys for oil and gas activities depicts areas that could potentially harbor chemosynthetic communities. This allows BOEM to require avoidance of any areas that are conducive to chemosynthetic growth. If a high-density community is subjected to direct impacts by bottom-disturbing activities, 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. 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 local 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 (Powell, 1995; Fisher, 1995). Routine activities of a CPA proposed action are expected to cause no damage to the ecological function or biological productivity of chemosynthetic communities. Widely scattered, high-density chemosynthetic communities would not be expected to experience impacts from routine oil and gas activities in deep water because the impacts would be limited by protections, as guidance provided in NTL 2009-G40. Impacts on chemosynthetic communities from routine activities associated with a CPA proposed action would be minimal to none. A detailed impact analysis of the routine impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on chemosynthetic communities can be found in Chapter 4.2.1.9.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.9 of the WPA 233/CPA 231 Supplemental EIS.

Accidental disturbances from a CPA proposed action, including oil spills and blowouts, have the potential to result in impacts on chemosynthetic communities of the CPA. Analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on chemosynthetic communities can be found in Chapter 4.2.1.9.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.9 of the WPA 233/CPA 231 Supplemental EIS.

Accidental events that could impact chemosynthetic communities are primarily limited to seafloor blowouts. A blowout at the seafloor could create a crater and could resuspend and disperse large quantities of bottom sediments within a 300-m (984-ft) radius from the blowout site. This could bury organisms located within that distance to some degree. The application of avoidance criteria for chemosynthetic communities provided as guidance in NTL 2009-G40 precludes the placement of a well within 610 m (2,000 ft) of any suspected site of a chemosynthetic community, therefore distancing the chemosynthetic community from the sedimentation resulting from a possible blowout.

Chemosynthetic communities could be susceptible to physical impacts, including smothering, from a blowout depending on bottom-current conditions. The guidance provided in NTL 2009-G40 greatly reduces the risk of these physical impacts by requiring a buffer of 610 m (2,000 ft) from wells. It clarifies the requirement to avoid potential chemosynthetic communities identified on the required geophysical survey records prior to approval of the structure emplacement. The 610-m (2,000-ft) avoidance required would protect sensitive communities from heavy sedimentation, with only light sediment components able to reach the communities in small quantities.

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) (Powell, 1995; Fisher, 1995). There is evidence that substantial impacts on these communities could permanently prevent reestablishment, particularly if hard substrate required for recolonization is buried by resuspended sediments from a blowout.

Potential accidental impacts from a CPA proposed action are expected to cause little damage to the ecological function or biological productivity of widely scattered, high-density chemosynthetic communities located at more than 610 m (2,000 ft) away from a blowout. Chemosynthetic communities could experience minor impacts from resuspended sediments that travel with currents, although the sediment concentration would be diluted with distance from the well.

If dispersants are applied to an oil spill, or if oil is ejected under high pressure, oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor in some form, either concentrated (near the source) or decayed (farther from the source), where it may impact patches of chemosynthetic community habitat in its path. As with sediments, the farther the dispersed oil travels, the more diluted the oil will become as it mixes with surrounding water.

There is some reason to believe the presence of oil would have a limited effect on chemosynthetic organisms because these communities live among oil and gas seeps; however, natural seepage is very constant and at very low rates as compared with the potential volume of oil released from a blowout or pipeline rupture. In addition, organisms inhabit certain niches within the gradients found at oil seeps, choosing locations with enough hydrocarbons to sustain their metabolism but not enough to be toxic. All seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources. Oil plumes that contact the seafloor before degrading could potentially affect sensitive benthic communities if they happen to encounter such a habitat in a localized area.

Accidental impacts associated with a CPA proposed action would likely result in only minimal impacts to chemosynthetic communities with adherence to the proposed biological stipulation and the guidance provided in NTL 2009-G40. One exception would be in the case of a low-probability catastrophic spill (**Appendix B**) combined with the application of dispersant or high-pressure ejection of oil, producing the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. The possible impacts, however, will be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect.

Summary and Conclusion

BOEM has reexamined the analysis for chemosynthetic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, with the understanding that no significant new information on chemosynthetic communities has been published since the release of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Therefore, no new significant information was discovered that would alter the impact conclusion for chemosynthetic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and the updated information provided in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Information

The greatest potential for cumulative adverse impacts to chemosynthetic deepwater benthic communities comes from OCS oil- and gas-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. Other offshore activities (non-OCS oil- and gas-related) such as anchoring, fishing and trawling and events such as storms, shipwrecks, and climate change can also potentially affect deepwater benthic communities. Impacts attributed to OCS activity occur at the same time as impacts due to other governmental and private projects and activities, as well as impacts due to pertinent natural processes and events that may adversely affect chemosynthetic communities. This cumulative analysis considers the effects of impact-producing factors related to past lease sales, a proposed CPA lease sale, reasonably foreseeable lease sale programs, and other natural and human impacting factors.

OCS Oil- and Gas-Related Impacts

The greatest potential for cumulative adverse impacts to occur to the deepwater benthic communities would come from those OCS oil- and gas-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 including low-probability catastrophic spills (**Appendix B**).

Sensitive deepwater communities appear to be widely scattered and not as rare as previously expected. Recent BOEM analyses of seafloor remote-sensing data indicate over 28,000 locations in the deep GOM that represent potential hard bottom habitats (Shedd, 2013). Guidance provided in NTL 2009-G40 describes surveys and avoidance measures, required prior to drilling or pipeline installation, that greatly reduce risks to these habitats. Studies have refined predictive information and confirmed the effectiveness of these provisions throughout all depth ranges of the GOM (Brooks et al., 2009). With the success of this work, confidence is increasing regarding the use of geophysical signatures for the prediction of chemosynthetic communities. These geophysical signatures enable BOEM to locate possible chemosynthetic communities and to implement avoidance measures in plan and pipeline reviews, which substantially reduce the possibility of impacting a chemosynthetic community.

As exploration and development continue on the Federal OCS, activities have moved farther into the deeper water areas of the Gulf of Mexico. 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, and the types of structures and mooring systems used. All activity levels for the cumulative scenario in the GOM for the years 2012-2051 are shown in **Table 3-3**. For the GOM deepwater offshore Subareas W200-800, W800-1600, W1600-2400, and W>2400, there are currently an estimated 3,180-4,510 exploration and delineation wells, 3,910-5,590 development and production wells to be drilled, and 115-141 production structures to be installed through the 40-year analysis period.

Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to patchy, high-density chemosynthetic communities, but substantial accumulations could result in more serious impacts. Sublethal impacts may include possible incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. Recovery from minor impacts is expected within several years, but even minor impacts are not expected based on avoidance measures provided by guidance in NTL 2009-G40, which precludes well development within 610 m (2,000 ft) of any suspected site of a deepwater benthic community. Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths >300 m (984 ft). Drill muds typically settle within about 100 m (328 ft) of the well site, while the majority of cuttings fall within 500 m (1,640 ft) (CSA, 2006). 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.” Such concentrations of muds and cuttings could extend beyond the distance required between the discharge and chemosynthetic communities, causing smothering of organisms. 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. Physical separation of well sites, great water depths, and adherence to the guidance provided in NTL 2009-G40 prevent separate activities from having overlapping effects.

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 such impacts occurred, the disturbance could lead to the destruction of a high-density chemosynthetic 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 it would not occur at all (Powell, 1995; Fisher, 1995).

The majority of deepwater chemosynthetic communities is of low density and is 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 an 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 communities are widely distributed, but they are 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 2009-G40, 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 absence of chemosynthetic communities prior to approval of the structure or anchor placements.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the immediate area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events. Subsea structure removals are not expected in water depths >800 m (2,625 ft), in accordance with 30 CFR part 250. The distance of separation required by adherence to the guidance provided in NTL 2009-G40 would protect chemosynthetic communities from sedimentation effects of deepwater blowouts.

The use of dispersants on surface oil is not anticipated to impact chemosynthetic communities. It is reported that chemically dispersed surface oil from the *Deepwater Horizon* oil spill remained in the top 6 m (20 ft) of the water column, where it mixed with surrounding waters and biodegraded (Lubchenco et al., 2010). Data from other studies on dispersant usage on surface plumes indicate that most of the dispersed oil remained in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Therefore, oil spills on the sea surface are expected to have little to no effect on deepwater benthic communities.

However, subsea oil plumes resulting from a seafloor blowout could affect sensitive deepwater communities. Major impacts to localized benthic habitat are possible in such an event, particularly when chemical dispersants are applied to oil releases at depth. A recent report documents damage to a deepwater coral community in an area that oil plume models predicted as the direction of travel for subsea oil plumes from the *Deepwater Horizon* oil spill (White et al., 2012). A coral community about 10 m x 12 m (33 ft x 40 ft) in size was severely damaged, and the study results identify *Macondo* oil as present on the corals (White et al., 2012; USDOI, BOEMRE, 2010). Such blowouts are rare and may not release catastrophic quantities of oil. Oil that is released would normally rise rapidly to the sea surface. However, if oil is ejected into deep water under high pressure, a plume of micro-droplets of oil can form. Treatment of the oil with dispersants at depth would also form a plume of oil that would be carried in whatever direction the water currents flow. This directional flow could only affect seafloor habitats that are downstream from the source.

Although the oil plume could be carried into direct contact with the seafloor at some distance from the source, a more likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; ITOPF, 2002). Oil would also reach the seafloor through consumption by plankton with excretion distributed over the seafloor (ITOPF, 2002). Dispersants reduce the oil’s ability to adhere to particles in the water column, slowing its rate of precipitation to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997), and oil droplets remain neutrally buoyant in the water column, creating a subsurface plume of oil (Lee et al., 2011a and 2011b; Adcroft et al., 2010). These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). The recovery time from an oiling event, if reestablishment is not permanently prevented, would be similar to that occurring from physical disturbance. Impacts to chemosynthetic communities from a catastrophic oil spill are described in **Appendix B**.

With over 28,000 potential locations of hard bottom habitats, it is likely that any subsea oil plume traveling more than a few miles on the deep seafloor would cross at least one of these potential habitats (Shedd, official communication, 2013). However, the plume may not contact chemosynthetic communities at that point. If the plume did make contact, it would result in a localized effect that is not expected to alter the wider population of the GOM.

In cases where high-density communities are subjected to greatly dispersed discharges or suspended 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; 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 any 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.

Oil and chemical spills on the sea surface are not considered to be a potential source of measurable impacts on any deepwater communities because of water depth. Oil spills from the surface would tend to float. Oil discharges at depth or on the bottom would tend to rise in the water column and similarly not impact the benthos unless dispersants are applied at depth. 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.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS activities such as anchoring, fishing, and trawling, and events such as storms, shipwrecks, and climate change can also potentially affect deepwater benthic communities. There are essentially only three fish (or “shellfish”) species considered important to deepwater commercial bottom fisheries—the yellowedge grouper (*Epinephelus flavolimbatus*), tilefish (*Lopholatilus chameleonticeps*), and royal red shrimp (*Hymenopenaeus robustus*). Yellowedge grouper habitat extends to 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, 2006). If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. The royal red shrimp is fished in some areas of the Gulf. Its depth range spans 180-730 m (591-2,395 ft), but most are obtained from depths of 250-475 m (820-1,558 ft) in the northeastern part of the Gulf of Mexico (GMFMC, 2004). This species is 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, 2006). If trawling occurred in sensitive areas of deepwater 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). Unlike other areas in the Atlantic and in Europe, bottom fishing and trawling efforts in the deeper water of the GOM are currently minimal, and impacts to deepwater benthic communities are negligible.

Other non-OCS oil- and gas-related sources of cumulative impact to deepwater benthic communities would be possible, but they are considered unlikely to occur. Storms generally cause little to no impacts at the depths (>300 m; 984 ft) that chemosynthetic communities occur. A storm could potentially cause some type of accident that could then cause secondary impacts, such as shipwrecks, but such occurrences would be rare. Essentially no anchoring from non-OCS oil- and gas-related activities occurs at the deeper water depths considered for these resources (>300 m; 984 ft). Some impacts are highly unlikely yet not impossible, such as the sinking of a ship or barge resulting in collision with or contaminant release directly on top of a sensitive, high-density chemosynthetic community.

One potential significant, large-scale source of impact could be potential efforts of carbon sequestration in the deep sea as a technique to reduce atmospheric carbon dioxide. This concept is still being considered but could have major ramifications. One side of the issue, even beyond the problems of sea-level increase and climate change, includes the serious risk to shallow-water benthic organisms through pH decreases, particularly those with calcium carbonate shells and skeletons (e.g., corals, serpulid worms, bryozoa, calcareous algae, etc.) (Kleypas et al., 1999; Barry et al., 2005; Shirayama and Thornton, 2005). However, the impacts of even very small excursions of pH and CO_2 in the deep sea could also have serious, even global, deep-sea ecosystem impacts. Kita and Ohsumi (2004) suggest sequestration of anthropogenic CO_2 could help reduce atmospheric CO_2, but they also summarize the potentially substantial biological impact on marine organisms. This issue continues to gain attention with the increased emphasis on climate change. Scientists suggested in the August 2006 issue of the *Proceedings of the National Academy of Sciences* that thousands of years of the Nation's carbon emissions could be stored in undersea sediments along the coasts (Zenz House et al., 2006).

Summary and Conclusion

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 oil- and gas-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. There is evidence that substantial impacts on these communities could permanently prevent reestablishment.

Possible catastrophic oil spills due to seafloor blowouts have the potential to devastate localized deepwater benthic habitats. However, these events are rare and would only affect a small portion of the sensitive benthic habitat in the GOM. Refer to **Appendix B** for a more detailed discussion of catastrophic blowouts.

Activities unrelated to the OCS Program include fishing and trawling, State oil and gas activities, storms and carbon sequestration. Because of the water depths in areas of chemosynthetic communities (>300 m; 984 ft) and the low density of commercially valuable fishery species, these activities are not expected to impact deepwater benthic communities.

The overall and incremental contribution of a CPA proposed action to cumulative impacts 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 or drill cutting discharges. Cumulative impacts to deepwater communities in the GOM are considered negligible because of the remoteness of communities from most impacts, the scattered and patchy nature of chemosynthetic communities, and the application of BOEM's avoidance criteria as guidance provided in NTL 2009-G40. A CPA proposed activity considered under the cumulative scenario is expected to cause negligible damage to the ecological function or biological productivity of chemosynthetic communities as a whole.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A broad Internet search for relevant new information and scientific journal articles made available since the publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS was conducted using a publicly available search engine. The websites for Federal and State agencies, as well as other organizations, were reviewed for newly released information. Sources investigated include the NOAA Ocean Exploration website, the Gulf of Mexico Alliance, USEPA, USGS, and coastal universities. Ongoing research projects funded by NOAA and the National Science Foundation are investigating chemosynthetic communities and impacts from the *Deepwater Horizon* explosion, oil spill, and response. No new analyses that are relevant to deepwater chemosynthetic communities and that would impact those analyses or conclusions have been made available since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

As identified in the resource analyses above and in Chapter 4.2.1.9 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, there remains incomplete or unavailable information on the effects of the *Deepwater Horizon* explosion, oil spill, and response on chemosynthetic communities that may be relevant to reasonably foreseeable significant adverse impacts. BOEM has determined that the information is not essential to a reasoned choice among alternatives because chemosynthetic communities are found throughout the Gulf and are in patchy distributions, minimizing the number that would be likely to be impacted by any single event. Available scientifically credible information has been applied by BOEM's subject-matter experts using accepted scientific methodologies.

4.1.1.10. Nonchemosynthetic Deepwater Benthic Communities

BOEM has reexamined the analysis for nonchemosynthetic deepwater benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for nonchemosynthetic deepwater benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

A detailed description of nonchemosynthetic deepwater benthic communities and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.10 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.10 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The potential routine impact-producing factors on nonchemosynthetic deepwater benthic communities of the CPA are bottom-disturbing activities associated with anchoring, structure emplacement, pipelaying, structure removal, and discharges of drill cuttings, muds, and produced water. Analysis of the routine impacts of OCS activities associated with a CPA proposed action on nonchemosynthetic deepwater benthic communities can be found in Chapter 4.2.1.10.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.10 of the WPA 233/CPA 231 Supplemental EIS.

Considerable mechanical damage could be inflicted upon sensitive nonchemosynthetic deepwater benthic communities by routine OCS drilling activities associated with a CPA proposed action if mitigations are not applied. Deepwater live bottom communities, primarily structured by the coral *Lophelia pertusa*, are the nonchemosynthetic deepwater benthic communities that would be sensitive to impacts from oil and gas activities. Bottom-disturbing activities associated with anchoring, structure emplacement, pipelaying, and structure removal cause localized bottom disturbances and disruption of benthic communities in the localized areas. If a sensitive community is subjected to direct impacts by bottom-disturbing activities, 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. 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 local community, and incremental damage to ecological relationships with the surrounding benthos. Should this occur, it could result in recovery times in the order of decades or more with the possibility of the community never recovering (FAO, 2008; Jones, 1992; Probert et al., 1997). However, impacts from bottom-disturbing activities directly on deepwater coral communities are expected to be rare because of the application of required protective measures as guidance provided in NTL 2009-G40, "Deepwater Benthic Communities."

Routine discharge of drill cuttings with associated muds can also affect the seafloor. In deep water, as opposed to shallower areas on the continental shelf, discharges of drilling fluids and cuttings at the sea surface are spread across broad areas of the seafloor and are generally distributed in thinner accumulations. A deepwater effects study funded by this Agency included determinations of the extent of muds and cuttings accumulations in approximately 1,000 m (3,281 ft) of water (CSA, 2006). Geophysical and chemical measurements indicated that a layer of cuttings and muds several centimeters thick was deposited within a 500-m (1,640-ft) radius of well sites. This suggests that the required 2,000-ft (610-m) distance would protect deepwater benthic communities from impacts. Discharges of produced waters on the sea surface, chemical spills, and deck runoff would be diluted in surface waters, having no effect on seafloor habitats.

Routine activities associated with a CPA proposed action are not expected to cause damage to the ecological function or biological productivity of sensitive deepwater live bottom communities (deep coral reefs) due to the consistent application of BOEM's protection guidance provided in NTL 2009-G40. Information included in required hazards surveys for oil and gas activities depicts areas that could potentially harbor nonchemosynthetic communities. This allows BOEM to require avoidance of any areas that are conducive to the growth of sensitive hard bottom communities. The same geophysical conditions associated with the potential presence of chemosynthetic communities also results in the potential occurrence of hard carbonate substrate and other associated, deepwater live bottom communities. Because of the guidance provided in NTL 2009-G40, these communities are generally avoided in exploration and development planning and in bottom-disturbing activities. Impacts on sensitive deepwater communities from routine activities associated with a CPA proposed action would be minimal to none.

Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to result in impacts to nonchemosynthetic deepwater benthic communities of the CPA. An analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on nonchemosynthetic deepwater benthic communities can be found in Chapter 4.2.1.10.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.10 of the WPA 233/CPA 231 Supplemental EIS.

Accidental events that could impact nonchemosynthetic deepwater benthic communities are primarily limited to seafloor blowouts. A blowout at the seafloor could create a crater and could resuspend and disperse large quantities of bottom sediments within a 300-m (984-ft) radius from the blowout site. This would destroy any organisms located within that distance by burial or modification of narrow habitat quality requirements. Substantial impacts on these communities could permanently prevent reestablishment, particularly if hard substrate required for recolonization is buried by resuspended sediments from a blowout. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms (e.g., brittle stars, sea pens, and 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. The application of avoidance criteria for deepwater coral communities as guidance provided in NTL 2009-G40 precludes the placement of a well within 610 m (2,000 ft) of any suspected site of a deepwater coral community, therefore distancing the community from sedimentation resulting from a possible blowout.

Accidental impacts due to oil spills caused by blowouts associated with a CPA proposed action would likely result in only minimal impacts to nonchemosynthetic communities with adherence to the guidance provided in NTL 2009-G40. A blowout could result in a catastrophic oil spill, though not reasonably foreseeable and not part of a CPA proposed action (**Appendix B**), but the distance requirements would tend to lessen but not necessarily eliminate the impacts. A large subsea spill combined with the application of dispersant or high-pressure ejection of oil could mix oil into the water column, resulting in a subsea plume. Such a plume could potentially cause devastating effects on local patches of habitat in its path where it physically contacts the seafloor. If such an event were to occur, it could take decades to reestablish the nonchemosynthetic community in that location. The possible impacts, however, would be localized due to the directional movement of an oil plume by the water currents and because the sensitive habitats have a scattered, patchy distribution. As with sediments, the farther the dispersed oil travels, the more diluted it would become as it mixes with the surrounding water, and bacteria would degrade the oil over time (and distance). Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect.

Summary and Conclusion

BOEM has reexamined the analysis for nonchemosynthetic deepwater benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for nonchemosynthetic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Information

The greatest potential for cumulative adverse impacts to nonchemosynthetic deepwater benthic communities comes from OCS oil- and gas-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. Other offshore activities (non-OCS) such as fishing and trawling and events such as climate change can also potentially affect deepwater benthic communities. Impacts attributed to OCS activity occur at the same time as impacts due to other governmental and private projects and activities, as well as impacts due to pertinent natural processes and events that may adversely affect nonchemosynthetic communities. The cumulative analysis considers the effects of impact-producing factors related to past lease sales, a proposed CPA lease sale, reasonably foreseeable lease sale programs, and other natural and human impacting factors.

OCS Oil- and Gas-Related Impacts

As exploration and development continue on the Federal OCS, activities have moved farther into the deeper water areas of the Gulf of Mexico. These activities would threaten sensitive habitats on the seafloor in their vicinity through 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. However, these potential impacts are mitigated by the application of avoidance requirements as guidance provided in NTL 2009-G40. The extent of these disturbances would 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 as guidance provided in NTL 2009-G40, which distances oil and gas activity from sensitive deepwater nonchemosynthetic communities.

Oil and gas activities on the OCS could affect local areas of deepwater nonchemosynthetic communities in several ways. Produced-water discharges and other surface discharges are too dilute by the time they would reach the bottom in >300-m (984-ft) water depths to cause impacts to such communities. Drilling discharges and resuspended sediments have the potential to cause minor, mostly sublethal impacts to patchy, high-density nonchemosynthetic communities, but substantial accumulations could result in more serious impacts. Sublethal impacts may include possible incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. Recovery from minor impacts is expected within several years, but even minor impacts are not expected based on avoidance measures provided as guidance in NTL 2009-G40, which precludes well development within 610 m (2,000 ft) of any suspected site of a deepwater benthic community. If physical disturbance (such as anchor damage) or extensive burial by muds and cuttings were to occur to high-density communities, impacts could be severe, with recovery time as long as 200 years for mature tube-worm communities (Powell, 1995; Fisher, 1995). Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths >300 m (984 ft). Drill muds typically settle within about 100 m (328 ft) of the well site, while the majority of cuttings fall within 500 m (1,640 ft) (CSA, 2006). Potential local cumulative impacts could result from accumulations of muds and cuttings resulting from consistent hydrographic conditions and the drilling of multiple wells from the same location, causing concentrations of material in a single direction or "splay." Such concentrations of muds and cuttings could potentially extend beyond the distance required between the discharge and nonchemosynthetic communities, causing smothering of organisms. 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. Physical separation of well sites, great water depths, and adherence to the guidance provided in NTL 2009-G40 prevent separate activities from having overlapping effects.

Localized areas of the seafloor may be affected by the installation of deepwater pilings, pipelines, anchors, and seafloor templates for mounting equipment. The greatest potential of physical disturbance is from anchor chains and cables. Deepwater work typically utilizes fewer anchors than work on the continental shelf. Because of the water depth (>300 m; 984 ft), pipelaying vessels and most drillships use dynamic positioning instead of anchors. This system uses computerized positioning controls of thrusters to maintain the position of the vessel. Most platform structures use numerous large anchors and cables that are fixed in place for the duration of the service life of the structure. Structure-removal activities could resuspend bottom sediments or cause physical impacts. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below. In deep water, the probability that infrastructure will be left on the seabed is likely higher. These potential impacts are mitigated by the application of avoidance requirements as guidance provided in NTL 2009-G40.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the immediate area. Subsea oil plumes resulting from a seafloor blowout could affect sensitive deepwater communities. This is especially true if dispersants are applied at depth. A recent report documents damage to a deepwater coral community in an area that oil plume models predicted as the direction of travel for subsea oil plumes from the *Deepwater Horizon* oil spill. A coral community about 10 m x 12 m (33 ft x 40 ft) in size was severely damaged, and the study results identify *Macondo* oil as present on the corals (White et al., 2012; USDOI, BOEMRE, 2010). Such blowouts are rare and may not release catastrophic quantities of oil. An analysis of impacts from a catastrophic oil spill is found in **Appendix B**. Oil that is released would normally rise rapidly to the sea surface. However, if oil is ejected into deep water under high pressure, a plume of micro-droplets of oil can form. Treatment of the oil with dispersants at depth would also form a plume of oil that would be carried in whatever direction the water currents flow. This directional flow could only affect seafloor habitats that are downstream from the source. Although the oil plume could be carried into direct contact with the seafloor at some distance from the source, a more likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; ITOPF, 2002). Oil would also reach the seafloor through consumption by plankton, with excretion distributed over the seafloor (ITOPF, 2002). Dispersants reduce the oil's ability to adhere to particles in the water column, slowing its rate of precipitation to the seafloor (McAuliffe et al., 1981a; Lewis and Aurand, 1997), and dispersed oil droplets remain neutrally buoyant in the water column, creating a subsurface plume of oil (Lee et al., 2011a and 2011b; Adcroft et al., 2010). These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). This suggests that nonchemosynthetic communities could come in contact with small amounts of oil in various stages of biodegradation.

Sensitive deepwater communities appear to be widely scattered and not as rare as previously expected. Recent BOEM analyses of seafloor remote-sensing data indicate over 28,000 locations in the deep GOM that represent potential hard bottom habitats (Shedd, 2013). While it is likely that any subsea oil plume traveling more than a few miles on the deep seafloor would approach at least one of these potential habitats, the plume may not contact nonchemosynthetic communities at that point. If the plume did make contact, it would result in a localized effect that is not expected to alter the wider populations in the Gulf of Mexico. Due to the patchy nature of sensitive deepwater communities and the directional flow of subsea oil plumes, only localized patches of sensitive communities could be affected.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS activities such as anchoring, fishing, and trawling, and events such as shipwrecks and climate change can also potentially affect deepwater benthic communities. There are essentially only three fish (or "shellfish") species considered important to deepwater commercial bottom fisheries—the yellowedge grouper (*Epinephelus flavolimbatus*), tilefish (*Lopholatilus chameleonticeps)*, and royal red shrimp (*Hymenopenaeus robustus)*. Yellowedge grouper habitat extends to about 275 m (902 ft). Bottom longlining for tilefish could potentially result in cumulative impacts to deepwater communities, as their habitat in the GOM extends to 540 m (1,772 ft) (FishBase, 2006). If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. The royal red shrimp is fished in depths of 250-475 m (820-1,558 ft) in the northeastern part of the Gulf of Mexico (GMFMC, 2004). This species is 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, 2006). If trawling occurred in sensitive areas of deepwater 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). Unlike other areas in the Atlantic and in Europe, bottom fishing and trawling efforts in the deeper water of the CPA are currently minimal, and impacts to deepwater benthic communities are negligible.

Other non-OCS oil- and gas-related sources of cumulative impact to deepwater benthic communities would be possible, but they are considered unlikely to occur. Essentially no anchoring from non-OCS oil- and gas-related activities occurs at the deeper water depths considered for these resources (>300 m; 984 ft). 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 nonchemosynthetic community.

One potential significant large-scale source of impact could be potential efforts of carbon sequestration in the deep sea as a technique to reduce atmospheric carbon dioxide. This concept is still being considered but could have major ramifications. One side of the issue, even beyond the problems of sea-level increase and climate change, includes the serious risk to shallow-water benthic organisms (particularly those with calcium carbonate shells and skeletons, e.g., corals, serpulid worms, bryozoa, calcareous algae, etc.) due to pH decreases (Kleypas et al., 1999; Barry et al., 2005; Shirayama and Thornton, 2005). However, the impacts of even very small excursions of pH and CO_2 in the deep sea could also have serious, even global, deep-sea ecosystem impacts. Acidification in the deep waters of the oceans could impact deepwater corals by reducing respiration rates (Hennige et al., 2013). Kita and Ohsumi (2004) suggest that sequestration of anthropogenic CO_2 could help reduce atmospheric CO_2, but they also summarize the potentially substantial biological impact on marine organisms. The issue continues to gain attention with the increased emphasis on climate change. Scientists suggested in the August 2006 issue of the *Proceedings of the National Academy of Sciences* that thousands of years of the Nation's carbon emissions could be stored in undersea sediments along the coasts (Zenz House et al., 2006). Such a plan needs further thought since nutrients in urban runoff to tropical seas are considered to be a major contributor to the decline of coral reefs. Substantial additional research is needed before any large-scale carbon sequestration actions would take place.

Summary and Conclusion

The most serious, impact-producing factor threatening nonchemosynthetic communities is physical disturbance of the seafloor, which could destroy the organisms of these communities. Such disturbance would most likely come from those OCS oil- and gas-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. There is evidence that substantial impacts on these communities could permanently prevent reestablishment.

Recent analyses reveal over 28,000 possible hard bottom locations across the deepwater Gulf of Mexico. Guidance provided in NTL 2009-G40 describes surveys and avoidance measures required prior to drilling or pipeline installation and greatly reduces risks. Studies have refined predictive information and have confirmed the effectiveness of these provisions throughout all depth ranges of the GOM (Brooks et al., 2009, Shedd, et al., 2011). With the success of this work, confidence is increasing regarding the use of geophysical signatures for the prediction of nonchemosynthetic communities. These geophysical signatures enable BOEM to locate possible nonchemosynthetic communities and to implement avoidance measures in plan and pipeline reviews, which substantially reduces the possibility of impacting a nonchemosynthetic community.

Possible catastrophic oil spills due to seafloor blowouts have the potential to devastate localized deepwater benthic habitats. Major impacts to localized benthic habitat are possible in such an event, particularly when chemical dispersants are applied to oil releases at depth. However, these events are rare and would only affect a small portion of the sensitive benthic habitat in the Gulf of Mexico. The recovery time from an oiling event, if reestablishment is not permanently prevented, would be similar to that occurring from physical disturbance. Refer to **Appendix B** for a more detailed discussion of catastrophic blowouts.

Among the activities unrelated to the OCS Program, fishing and trawling represent the greatest threat to nonchemosynthetic communities. Because of the water depths in areas of nonchemosynthetic communities (>300 m; 984 ft) and the low density of commercially valuable fishery species, these activities are not expected to impact deepwater benthic communities. Storms are unlikely to impact communities at such great water depths, but they could cause secondary impacts such as shipwrecks. Climate change would potentially impact such communities, primarily if carbon dioxide concentrations increased to projected levels, leading to ocean acidification and resulting in impacts to deepwater corals. Large-scale carbon sequestration programs, should they ever be initiated, could potentially affect levels of pH and CO_2 in the deep sea, with potentially substantial biological impacts on marine organisms.

The overall and incremental contribution of a CPA proposed action to cumulative impacts 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 or drill cutting discharges. Cumulative impacts to deepwater communities in the GOM are considered negligible because of the remoteness of communities from most impacts, the scattered and patchy nature of nonchemosynthetic communities, and the application of BOEM's avoidance criteria as guidance provided in NTL 2009-G40. A CPA proposed activity considered under the cumulative scenario is expected to cause negligible damage to the ecological function or biological productivity of nonchemosynthetic communities as a whole.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A broad Internet search for relevant new information and scientific journal articles made available since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS was conducted using a publicly available search engine. The websites for Federal and State agencies, as well as other organizations, were reviewed for newly released information. Sources investigated include the NOAA Ocean Exploration website, the Gulf of Mexico Alliance, USEPA, USGS, Science Direct, Elsevier, the NOAA Central Library National Oceanographic Data Center, JSTOR, and coastal universities. Ongoing research projects funded by NOAA and the National Science Foundation are investigating nonchemosynthetic communities and impacts from the *Deepwater Horizon* explosion, oil spill, and response.

Several studies have been published that provide insight into aspects of the spill and its effects. White et al. (2012) provided evidence that the *Deepwater Horizon* oil spill impacted deepwater ecosystems including corals. One deepwater coral site at a depth of 1,370 m (4,495 ft) was reported as severely damaged following the *Deepwater Horizon* explosion and oil spill. The site is in Mississippi Canyon Block 294, 11 km (7 mi) southwest of the spill location. The site includes hard substrate supporting coral in an area approximately 10 x 12 m (33 x 39 ft) (White et al., 2012). Sabourin et al. (2012) found that corals are bioaccumulating PAH's. Goodbody-Gringley et al. (2013) found that experimental exposure of coral larvae to oil and COREXIT significantly decreased larval settlement and survival in *Montastraea faveolata* and *Porites astreoides.* While the recent research has provided new information regarding impacts to nonchemosynthetic communities from oil spills, this new information does not change the conclusions of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because such a low-probability catastrophic event is unlikely to occur and because BOEM considered the potential irreversible effects to nonchemosynthetic communities in **Appendix B** of this Supplemental EIS.

As identified in the resource analyses above and in Chapter 4.2.1.10 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 2321 Supplemental EIS, there remains incomplete or unavailable information on the effects of the *Deepwater Horizon* explosion, oil spill, and response on deepwater live bottom communities that may be relevant to reasonably foreseeable significant adverse impacts. BOEM has determined that the information is not essential to a reasoned choice among alternatives because deepwater live bottom communities are found throughout the Gulf and are in patchy distributions, minimizing the number that would be likely to be impacted by any single event. Available scientifically credible information has been applied by BOEM's subject-matter experts using accepted scientific methodologies.

4.1.1.11. Soft Bottom Benthic Communities

BOEM has reexamined the analysis for soft bottom benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for soft bottom benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

A detailed description of soft bottom benthic communities and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.11 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.11 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

A majority of the oil and gas exploration in the GOM is conducted on soft seafloor sediments. The potential routine impact-producing factors on soft bottom benthic communities of the CPA are infrastructure emplacement (i.e., anchors, structures, and pipelines), turbidity and smothering, drilling-effluent and produced-water discharges, and infrastructure removal. Disturbances of soft bottom benthic communities may cause localized disruptions to benthic community composition and an alteration in food sources for some large invertebrate and finfish species. A detailed impact analysis of the routine impacts of OCS activities associated with a CPA proposed action on soft bottom benthic communities can be found in Chapter 4.2.1.11.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.11 of the WPA 233/CPA 231 Supplemental EIS.

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels are routine oil and gas OCS oil- and gas-related threats that disturb areas of the seafloor. The size of the areas affected by chains associated with anchors and pipeline-laying barges depends on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current (Lissner et al., 1991). Anchor damage could result in the crushing and smothering of infauna. Anchoring often destroys a wide swath of habitat when an anchor is dragged over the seafloor while being set or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to infauna as a result of anchoring may take approximately 1 year to recover, depending on the reproductive cycle and immigration of surrounding communities (Rhodes and Germano, 1982).

Localized impacts to comparatively small areas of the soft bottom benthic communities would occur as a result of structure emplacement on the OCS, and the impacts would be on a relatively small area of the seafloor compared with the overall area of the seafloor of the CPA (268,922 km^2; 103,831 mi^2) and the entire GOM (645,825 km^2; 249,354 mi^2). The estimated footprint of all active platforms on the continental shelf in the GOM is approximately 14,491,864 ft^2 (1.346 km^2; 0.520 mi^2) (USDOI, BOEM, 2014; LGL Ecological Research Associates, Inc. and Science Applications International Corporation, 1998), which is approximately 0.0002 percent of the estimated area of seafloor in the GOM. Based on these values, the impacts that may occur to the seafloor around platforms would be a fraction of the entire soft bottom community of the GOM. The placement of a structure on the seafloor would destroy some soft bottom benthic habitat; however, the impacts are localized. The greatest impact is the alteration of benthic communities as a result of smothering, chemical toxicity, and substrate change.

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, sublethal toxic effects (impacts to growth and reproduction), and change in substrate grain size. Smothering of infauna by drilling discharges may be one of the greatest impacts to localized communities near a well, especially one that has shunted its cuttings to the seafloor to protect nearby sensitive, hard bottom features. The heaviest concentrations of well cuttings and drilling fluids, for both water-based and synthetic-based drilling muds, have been reported within 100 m (328 ft) of wells and are shown to decrease beyond that distance (Kennicutt et al., 1996; CSA, 2004). The impacts to the benthic communities from the deposition of cuttings and muds are localized, and impacts generally occur within a few hundred meters of platforms, with the greatest impacts close to the platform. Communities that are smothered by cuttings would be replaced by more tolerant pioneering species, resulting in a shift in species dominance (Montagna and Harper, 1996). These pioneer habitats would be similar to the early successional communities that predominate throughout areas of the Gulf of Mexico that are frequently disturbed (Gaston et al., 1998; Diaz and Solow, 1999; Rabalais et al., 2002a). Although impacts are locally drastic, cumulative impacts over the seafloor of the Gulf of Mexico are anticipated to be very small, as such comparatively small areas are affected.

Produced waters from petroleum production operations are not likely to have a great impact on soft bottom communities. Produced waters are rapidly diluted and impacts are generally only observed within proximity of the discharge point, and acute toxicity that may result from produced waters occurs "within the immediate mixing zone around a production platform" (Gittings et al., 1992a; Holdway, 2002). There have been no reported impacts to marine organisms or sediment contamination beyond 100 m (328 ft) of the produced-water discharge (Neff and Sauer, 1991; Trefry et al., 1995). Therefore, impacts to infauna are anticipated to be localized and only affect a small portion of the entire seafloor of the Gulf of Mexico.

Traditional pipeline-laying barges (as opposed to dynamically positioned barges) affect more seafloor than other anchoring impacts. These barges typically use an array of 8-12 anchors weighing about 4,500 kg (10,000 lb) each. While the large anchors crush organisms in their footprint, a much larger area is affected by anchor cable sweep as the barge is pulled forward to lay the pipeline by reeling-in forward cables and reeling-out aft cables. The anchors are reset repeatedly to forward positions to allow the barge to "crawl" forward. In this way, the anchor sweep scours parallel paths on each side of the vessel where the cables touch the seafloor. The width of the scoured paths varies with water depth (deeper water equals longer cables) and may be as much as 1,500 m (5,000 ft) to each side (only a portion of the cable adjacent to the anchor touches the seafloor). Another major impact of the process is pipeline burial. In waters ≤60 m (200 ft), pipeline burial is required. This involves trenching up to 3.3 m (10.8 ft) deep in the seafloor from a water depth of ≤60 m (200 ft) to shore. This is a severe disturbance of the trenched area and creates a large turbidity plume. Resuspended sediments can cause 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 areas in the vicinity of the barge. Impacts may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003).

Explosive structure-removal operations disturb the seafloor and can physically lift nearby benthic organisms from their benthic habitat. An explosion may kill benthic organisms in the immediate blast zone by violent uplift or heavy deposition of disturbed sediments on top of organisms. Benthic organisms outside of the immediate blast zone are not expected to suffer much damage as many sessile benthic organisms are reported to resist the concussive force of structure-removal-type blasts (O'Keeffe and Young, 1984). O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Impacts to invertebrates outside of the immediate blast zone are anticipated to be minimal as they do not have air bladders inside their bodies that may burst with explosions, as some fish do (Schroeder and Love, 2004).

Any activity that may affect the soft bottom communities would only impact a small portion of the overall area of the seafloor of the Gulf of Mexico. Because the soft bottom substrate is ubiquitous throughout the Gulf of Mexico, there are no lease stipulations to avoid these communities. However, other routine practices restrict detrimental activities that could cause undue harm to benthic habitats (e.g., discharge restrictions, debris regulations, and NPDES permits).

Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to cause damage to infaunal communities of the CPA. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on soft bottom benthic communities can be found in Chapter 4.2.1.11.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.11 of the WPA 233/CPA 231 Supplemental EIS.

Only a very small portion of the seafloor of the Gulf of Mexico would experience lethal impacts as a result of blowouts, surface, and subsurface oil spills and the associated affects because of the small amount of proportional space that OCS activities occupy on the seafloor. The greatest impacts would be closest to the spill, and impacts would decrease with distance from the spill. Contact with spilled oil at a distance from the spill would likely cause sublethal to immeasurable effects to benthic organisms because the distance of activity would prevent contact with concentrated oil. Oil from a subsurface spill that eventually reaches benthic communities would be primarily sublethal, and impacts would be at the local community level. Any sedimentation and deposition of oil adhered to sediment would also be at low concentrations and widely dispersed by the time it reaches the seafloor, also resulting in sublethal impacts. Also, any local communities that are lost would be repopulated fairly rapidly (Neff, 2005). Although an oil spill may have some detrimental impacts, especially closest to the occurrence of the spill, the impacts may be no greater than natural biological fluctuations (Clark, 1982), and impacts would be to a relatively small portion of the overall Gulf of Mexico.

Summary and Conclusion

BOEM has reexamined the analysis for soft bottom benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for soft bottom benthic communities presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The vast majority of the Gulf of Mexico seabed is comprised of soft sediments. Because drilling activity is concentrated on the soft seabed, the greatest number of impacts occurs on soft bottom, benthic environments and to the animals that live in and on the sediment. This cumulative analysis considers the effects of impact-producing factors related to soft bottoms of the Gulf of Mexico continental shelf. A CPA proposed action plus those activities related to prior and future OCS lease sales are considered; in this discussion, these are referred to as “OCS oil- and gas-related” factors. Specific OCS oil- and gas-related, impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, and blowouts. Other impacting factors (non-OCS oil- and gas-related factors) that may occur and adversely affect soft bottom benthic communities include commercial fisheries (bottom trawling), anchoring by recreational boats and other non-OCS commercial vessels, spillage from non-OCS oil- and gas-related vessels, cable laying, sand mining, hypoxia (low oxygen levels ≤2 ppm), and storm events, all which have the potential to damage soft bottom benthic communities.

OCS Oil- and Gas-Related Impacts

There are no BOEM stipulations that require avoidance of soft bottom benthic communities because they are so ubiquitous throughout the seafloor of the Gulf of Mexico. Most of the bottom surface area of the GOM (645,825 km^2; 249,354 mi^2) and specifically the CPA (268,922 km^2; 103,831 mi^2) are soft mud bottoms, and this substrate is where drilling occurs. It is important to note, however, that because the soft bottom benthic communities comprise a majority of the seafloor of the Gulf of Mexico, impacts are not detrimental to the Gulfwide community of these habitats. Also, because a large portion of the seafloor is subject to natural fluctuations and physical disturbances (such as storms and yearly hypoxic events), a permanent early successional community occupies much of the seafloor and enables rapid recovery of disturbed areas, including those impacted by OCS oil and gas activity.

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels are routine OCS oil- and gas-related threats that disturb areas of the seafloor. The size of the areas affected by chains associated with anchors and pipeline-laying barges depends on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current (Lissner et al., 1991). Anchor damage could result in the crushing and smothering of infauna. Anchoring often destroys a wide swath of habitat when an anchor is dragged over the seafloor while being set or by the vessel swinging at anchor, causing the anchor chain to drag over the seafloor (Lissner et al., 1991). Damage to infauna as a result of anchoring may take approximately 1 year to recover, depending on the reproductive cycle and immigration of surrounding communities (Rhodes and Germano, 1982).

The placement of a structure on the seafloor also destroys some soft bottom benthic habitat; however, the impacts are localized to comparatively small areas of the seafloor compared with the overall area of the seafloor of the CPA (268,922 km^2; 103,831 mi^2) and the entire GOM (645,825 km^2; 249,354 mi^2). The estimated footprint of all platforms on the continental shelf in the GOM is approximately 14,491,864 ft^2 (1,346,338 m^2; 0.520 mi^2; 1.346 km^2) (USDOI, BOEM, 2014; LGL Ecological Research Associates, Inc. and Science Applications International Corporation, 1998), which is approximately 0.0002 percent of the estimated area of seafloor in the GOM. Based on these values, the impacts that may occur to the seafloor around platforms would be a fraction of the entire soft bottom community of the GOM.

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, sublethal toxic effects (impacts to growth and reproduction), and change in substrate grain size. Smothering of infauna by drilling discharges may be one of the greatest impacts to localized communities near a well, especially one that has shunted its cuttings to the seafloor to protect nearby sensitive, hard bottom features. The heaviest concentrations of well cuttings and drilling fluids, for both water-based and synthetic-based drilling muds, have been reported within 100 m (328 ft) of wells and are shown to decrease beyond that distance (Kennicutt et al., 1996; CSA, 2004). The impacts to the benthic communities from the deposition of cuttings and muds are localized, and impacts generally occur within a few hundred meters of platforms, with the greatest impacts close to the platform. Communities that are smothered by cuttings would be replaced by more tolerant pioneering species, resulting in a shift in species dominance (Montagna and Harper, 1996). These pioneer habitats would be similar to the early successional communities that predominate throughout areas of the Gulf of Mexico that are frequently disturbed (Gaston et al., 1998; Diaz and Solow, 1999; Rabalais et al., 2002a). Although impacts are locally drastic, cumulative impacts over the seafloor of the Gulf of Mexico are anticipated to be very small, as such comparatively small areas are affected.

Produced waters from petroleum operations are not likely to have a great impact on soft bottom communities. Produced waters are rapidly diluted and impacts are generally only observed within proximity of the discharge point, and acute toxicity that may result from produced waters occurs "within the immediate mixing zone around a production platform" (Gittings et al., 1992a; Holdway, 2002). There have been no reported impacts to marine organisms or sediment contamination beyond 100 m (328 ft) of the produced-water discharge (Neff and Sauer, 1991; Trefry et al., 1995). Therefore, impacts to infauna are anticipated to be localized and only affect a small portion of the entire seafloor of the Gulf of Mexico.

Traditional pipeline-laying barges (as opposed to dynamically positioned barges) affect more seafloor than other anchoring impacts. These barges typically use an array of 8-12 anchors weighing about 4,500 kg (10,000 lb) each. While the large anchors crush organisms in their footprint, a much larger area is affected by anchor cable sweep as the barge is pulled forward to lay the pipeline by reeling-in forward cables and reeling-out aft cables. The anchors are reset repeatedly to forward positions to allow the barge to "crawl" forward. In this way, the anchor sweep scours parallel paths on each side of the vessel where the cables touch the seafloor. The width of the scoured paths varies with water depth (deeper water equals longer cables) and may be as much as 1,500 m (5,000 ft) to each side (only a portion of the cable adjacent to the anchor touches the seafloor). Another major impact of the process is pipeline burial. In waters ≤60 m (200 ft), pipeline burial is required. This involves trenching up to 3.3 m (10.8 ft) deep in the seafloor from a water depth of ≤60 m (200 ft) to shore. This is a severe disturbance of the trenched area and creates a large turbidity plume. Resuspended sediments can cause 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 areas in the vicinity of the barge. Impacts may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003).

Both explosive and nonexplosive structure-removal operations disturb the seafloor and can physically lift nearby benthic organisms from their benthic habitat. An explosion may kill benthic organisms in the immediate blast zone by violent uplift or heavy deposition of disturbed sediments on top of organisms. Benthic organisms outside of the immediate blast zone are not expected to suffer much damage as many sessile benthic organisms are reported to resist the concussive force of structure-removal-type blasts (O'Keeffe and Young, 1984). O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Impacts to invertebrates outside of the immediate blast zone are anticipated to be minimal as they do not have air bladders inside their bodies that may burst with explosions, as some fish do (Schroeder and Love, 2004).

Accidental impacts from OCS oil- and gas-related activities can also affect benthic communities. Surface oil slicks (released offshore from vessels or released subsea and risen to the sea surface) can be moved toward shore by winds, but oil mixed into the water column is moved by water currents, which do not generally travel toward shore (Pond and Pickard, 1983; Inoue et al., 2008). Surface oil spills and physically dispersed oil released from tankers may impact shallow, nearshore benthic communities. Disturbance of the sea surface by storms can mix surface oil 10-20 m (33-66 ft) into the water column (McAuliffe et al., 1975 and 1981a; Lange, 1985; Tkalich and Chan, 2002). This may result in direct oil contact for shallow, nearshore benthic communities. Direct oiling or exposure to water soluble fractions of oil may result in lethal impacts to organisms (Byrne, 1989; Suchanek, 1993; Beiras and Saco-Álvarez, 2006) or impaired embryonic development (Byrne and Calder, 1977; Nicol et al., 1977; Vashchenko, 1980). Benthic communities farther offshore, in deeper water, would be protected from direct physical contact of surface oil by depth below the sea surface. Any dispersed surface oil from a tanker or rig spill that may reach the benthic communities on the seafloor of the Gulf of Mexico at a depth greater than 10 m (33 ft) would be expected to be at very low concentrations (less than 1 ppm) (McAuliffe et al., 1981a and 1981b; Lewis and Aurand, 1997). Such concentrations may not be life threatening to adult stages, but they may harm larval or embryonic life stages of benthic organisms (Byrne, 1989; Suchanek, 1993; Fucik et al., 1995; Beiras and Saco-Álvarez, 2006).

Blowouts may impact the biota of the soft bottom benthic communities. If any blowouts from wells occur, the suspended sediments should settle out of the water column fairly quickly, locally smothering benthic organisms near the well. Any oil that adhered to the sediment would also smother the benthic communities below. The greatest impacts would be closest to the well, where the heaviest deposits of sediment would occur. Any oil that becomes entrained in a subsurface plume would be dispersed as it travels in the water column (Vandermuelen, 1982; Tkalich and Chan, 2002). Subsea oil plumes near the seafloor would pass over smooth soft bottom, continuing the processes of diffusion and biodegradation. These plumes would continue to be dispersed over a wide area in low concentrations with sublethal to immeasurable effect. If concentrated oil were to contact the soft bottom communities directly, the impacts may include lethal effects with loss of habitat and biodiversity, contamination of substrate, change in community structure, and failed reproductive success. Damage to infauna as a result of subsurface plume exposure may take approximately 1 year to recover, depending on the reproductive cycle and immigration of surrounding communities (Rhodes and Germano, 1982).

Oil that was deposited on the seafloor as a result of the *Deepwater Horizon* oil spill is discussed in this section as part of the cumulative impacts that may occur to soft bottom benthic communities. In November 2010, it was estimated that 26 percent of the released oil from the *Macondo* well remained in the environment as oil on or just below the water surface as a light sheen or tarballs; oil that was washed ashore or collected from the shore; and oil that was in the sediments (Lubchenco et al., 2010). Currently, the bulk deposits of oil have been removed from beaches, and the remaining oil that reached shorelines has been buried (e.g., through wave action and hurricanes) and is weathering over time (OSAT-2, 2011). The greatest concentrations of oil deposited on the seafloor were near the wellhead, and the concentrations decreased with distance from the source. Sediment concentrations of hydrocarbons that exceeded USEPA aquatic life benchmarks (concentration for potential adverse effects) occurred in only seven samples collected within 3 km (2 mi) of the *Macondo* well, and concentrations reached background levels at 10 km (6 mi) from the well, indicating a limited radius of severe impact (OSAT, 2010). Benthic abundance was reduced the most within the 3-km (2-mi) circular radius around the wellhead and was moderately affected along an elongated northeast-southwest axis that extends 8.5 km (5.3 mi) northeast and 17 km (11 mi) southwest of the wellhead (Montagna et al., 2013). The oil that was deposited on the floor of the Gulf has also weathered over time and biodegradation of oil in the sediment was greater with distance from the wellhead (OSAT, 2010; Liu et al., 2012). The concentrations of total *n*-alkanes (hydrocarbon chains) and total PAH's (hydrocarbon rings) were approximately three times higher at a station 2 km (1.2 mi) from the wellhead than they were at a station 6 km (3.7 mi) from the wellhead 1 year after the spill (Liu et al., 2012). The sediment was more enriched with the larger compounds (both *n*-alkanes and PAH's), indicating the biological degradation of the smaller compounds and biodegradation was more intense at the station farther from the wellhead.

The cumulative impact to soft bottoms of possible future oil spills, along with the *Deepwater Horizon* oil spill, is anticipated to be small. The limited data currently available on the impacts of the *Deepwater Horizon* explosion, oil spill, and response make it difficult to define impacts to the soft bottom communities in the GOM; although, as described above, the greatest impacts were close to the well and decreased with distance. The PAH's are also breaking down with time, reducing contamination in the affected areas. Also, seafloor samples indicated that the only sediment exceedances of USEPA's chronic aquatic life benchmarks occurred within 3 km (2 mi) of the well and samples fell to background levels at a distance of 10 km (6 mi) from the well (OSAT, 2010). Therefore, the acute impacts of any large-scale blowout to soft bottom benthic communities would likely be limited in scale and influenced by directional currents, and any additive impacts of several blowouts should have acute effects in only small areas, with possible sublethal impacts occurring over a larger area. Overall, the locally impacted seafloor will be very small compared with the overall size of the seafloor of the CPA (268,922 km^2; 103,831 mi^2) to the GOM (645,825 km^2; 249,354 mi^2). It will not impact the overall infaunal population.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS oil- and gas-related activities have a greater potential to affect the soft bottom communities of the region than BOEM-regulated OCS oil- and gas-related activities. Natural events such as storms, extreme weather, and fluctuations of environmental conditions may impact soft bottom infaunal communities. Soft bottom communities occur from the shoreline into the deep waters of the Gulf of Mexico. Storms can physically affect shallow bottom environments, causing an increase in sedimentation, burial of organisms by sediment, a rapid change in salinity or dissolved oxygen levels, storm surge scouring, remobilization of contaminants in the sediment, and abrasion and clogging of gills as a result of turbidity (Engle et al., 2008). Storms have also been shown to uproot benthic organisms from the sediment and suspend organisms in the water column (Dobbs and Vozarik, 1983). Large storms may devastate infaunal populations; for example, 2 months after Hurricane Katrina, a significant decrease in the number of species, species diversity, and species density occurred in coastal waters off Louisiana, Mississippi, and Alabama (Engle et al., 2008). Such impacts may have substantial effects on benthic communities, although these impacts are generally temporary as recolonization, and immigration from nearby benthic communities should occur within a year. As a result of storm events, a permanent early successional community occupies much of the seafloor and enables rapid recovery of disturbed areas.

Hypoxic conditions of inconsistent intensities and ranges also occur annually in a band that stretches along the Louisiana-Texas continental shelf each summer (Rabalais et al., 2002a). These conditions can be caused by a combination of several factors, including warm water temperature, nutrient input, storm runoff, drainage, and algal blooms. The dissolved oxygen levels in the Gulf of Mexico's hypoxic zone are <2 ppm. Such low concentrations are lethal to many benthic organisms and may result in the loss of some benthic populations. Recolonization of devastated areas by populations from unaffected neighboring soft bottom substrate would be expected to occur within a relatively short period of time (Thistle, 1981; Dubois et al., 2009).

Recreational boating, fishing, and import tankering may have limited impact on soft bottom communities. Ships anchoring near major shipping fairways of the GOM or recreational fishing boats setting anchor would impact bottom habitats. Anchor placement may crush and eliminate infauna in the footprint of the anchor. Anchoring impacts are localized to the anchor footprint and are temporary, as nearby organisms can repopulate the affected area rapidly. Oil spilled from any of these vessels could also result in similar impacts to oil spilled from OCS oil- and gas-related vessels.

Damage resulting from commercial fishing, especially bottom trawling, may have a severe impact on soft bottom benthic communities. Bottom trawling in the Gulf of Mexico primarily targets shrimp from nearshore waters to depths of approximately 90 m (295 ft) (NRC, 2002). Some studies have indicated that trawled seafloor has reduced species diversity compared with untrawled seafloor (McConnaughey et al., 2000), while others do not show a statistical difference between trawled and untrawled seafloor, although species dominance may shift (Van Dolah et al., 1991). Trawl trails may scour sediment, killing infauna, and epifaunal organisms may be physically removed (Engel and Kvitek, 1998). A review of the use of tickle chains on trawls indicated damage to shallow infauna and surface-dwelling benthic species (Van Dolah et al., 1991). Trawling also contributes regularly to turbidity, as nets drag the seafloor, leaving trails of suspended sediment. Repetitive disturbance by trawling activity may lead to a community dominated by opportunistic species (Engel and Kvitek, 1998). Recovery from the passing of a trawl net would begin to occur with the following reproduction cycle of surrounding benthic communities (Rhodes and Germano, 1982), but populations may be severely impacted by repetitive trawling activity (Engel and Kvitek, 1998).

Cable laying may involve trenching in the seafloor to bury the cable to protect it from seafloor disturbances, such as trawling. Seafloor trenching creates a large turbidity plume where resuspended sediments can cause 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 areas in the vicinity of the trenching activity. Impacts may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003). In turn, the suspended sediment may cause heavy depositions that could smother benthic communities below.

Sand mining of the seafloor for the use of replenishing beaches after storm damage can also impact soft bottom benthic communities. Mining the seafloor alters the seafloor, which would result in the physical removal of infaunal and epifaunal benthic organisms, displacement of benthic fishes that feed on the benthic organisms, suspended sediment and turbidity that can clog gills, and sediment deposition that can smother organisms (Byrnes et al., 2004; Diaz et al., 2004). Benthic infaunal abundance would recover from such activity within 1-3 years, but the recovery of species composition would take longer (Byrnes et al., 2004). Initial colonization would include the rapidly reproducing pioneering organisms that are abundant in the GOM.

As discussed above, severe physical damage may occur to soft bottom sediments and the associated benthic communities as a result of non-OCS oil- and gas-related activities. It is assumed infauna associated with soft bottom sediments of the GOM are well adapted to natural disturbances such as turbidity and storms. However, human disturbance, such as trawling and sand mining or non-OCS oil- and gas- related activity oil spills, could cause severe damage to infauna, possibly leading to changes of physical integrity, species diversity, or biological productivity. If such non-OCS oil- and gas-related human disturbances were to occur, recovery to pre-impact conditions could take approximately a year (Neff, 2005; Lu and Wu, 2006), with the overall recovery time depending on the presence of recolonizers nearby, the time of year for reproduction of those colonizers, the currents and water circulation patterns, the extent of possible oiling, and the ability of the recolonizers to tolerate the sediment conditions (Ganning et al., 1984). Recovery of benthic populations in soft subtidal environments, however, has been reported to take up to 5-10 years after oiling (Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000). However, because some benthic communities in the northern Gulf of Mexico are permanently in early community successional stages due to frequent disturbances, full recovery may occur very quickly (Gaston et al., 1998; Diaz and Solow, 1999; Rabalais et al., 2002a).

Summary and Conclusion

Impacts from routine activities of OCS oil- and gas-related operations including anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges of muds and cuttings, operational discharges of produced waters, accidental oil spills, and blowouts associated with OCS activities may have locally devastating impacts on infaunal communities, but the cumulative effect on the overall seafloor and infaunal communities on the Gulf of Mexico would be very small. Soft bottom benthic communities are ubiquitous throughout the GOM and often remain in an early successional stage due to natural fluctuation. Therefore, the activities of OCS production of oil and gas would not cause additional severe cumulative impacts to soft bottom benthic communities. Long-term OCS oil- and gas- realted activities are not expected to adversely impact the entire soft bottom environment because the local impacted areas are extremely small compared with the entire seafloor of the Gulf of Mexico and because impacted communities are repopulated relatively quickly.

Non-OCS oil- and gas-related activities that may occur on soft bottom benthic substrate include recreational boating and fishing, commercial fishing, import tankering, cable laying, sand mining, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions. These activities could cause temporary damage to soft bottom communities. Ships and fishermen anchoring on soft bottoms could crush and smother underlying organisms. Cable laying and sand mining could suspend sediments and impact benthic organisms through dermal abrasion, clogged gills, and burial. During severe storms, such as hurricanes, large waves may stir bottom sediments, which cause scouring, remobilization of contaminants in the sediment, abrasion and clogging of gills as a result of turbidity, uprooting benthic organisms from the sediment, and an overall result in decreased species diversity (Engle et al., 2008; Dobbs and Vozarik, 1983). Yearly hypoxic events may eliminate many species from benthic populations over a wide area covering most of the CPA and part of the WPA continental shelf (Rabalais et al., 2002a).

The incremental contribution of a CPA proposed action 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, however, are small compared with the overall size and ubiquitous composition of the soft bottom benthic communities in the Gulf of Mexico. Non-OCS oil- and gas-related factors, such as storms, trawling, non-OCS oil- and gas-related spills, and hypoxia, are likely to impact the soft bottom communities on a more frequent basis. Impacts from OCS activities are also somewhat minimized by the fact that these communities are ubiquitous throughout the CPA and can recruit quickly from neighboring areas.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources (NOAA's Gulf Spill Restoration Publications website, NOAA's Environmental Response Management Application [ERMA] Gulf Response website, NOAA's *Deepwater Horizon* Archive Publications and Factsheets; the Gulf of Mexico Sea Grant *Deepwater Horizon* Oil Spill Research and Monitoring Activities Database; the RestoreTheGulf.gov website, and the *Deepwater Horizon* Oil Spill Portal), as well as recently published journal articles and Federal documents was conducted to determine the availability of recent information on topographic features. The search revealed new information on the proposed threatened/endangered listing of coral species in the GOM, information that is pertinent to this Supplemental EIS.

Additional information has been published since the release of the OSAT 2010 report. Using the sediment data collected during the OSAT effort, the footprint of the *Deepwater Horizon* oil spill was mapped in Geographic Information Systems (GIS) (Montagna et al., 2013). In addition, analyses were conducted to determine the correlation between impacts to benthic organisms in relation to total PAH, barium, distance from the *Deepwater Horizon* wellhead, and distances to seeps. Benthic communities were altered in areas where there were strong positive correlations with organic enrichment, PAH, and barium. For example, nematodes (opportunistic worms) were abundant in areas that had increased organic enrichment as a result of the spill (Montagna et al., 2013). The impacts to benthic diversity were correlated with the deposition of oil around the wellhead and the directional flow of the subsea plume. Benthic abundance was reduced the most within a 3-km (1.9-mi) circular radius around the wellhead and was moderately affected along an elongated northeast-southwest axis that extends 8.5 km (5.3 mi) northeast and 17 km (10.6 mi) southwest of the wellhead (Montagna et al., 2013). There was not a correlation between benthic abundance and diversity and distance from seafloor hydrocarbon seeps, indicating that the alterations observed were probably a result of the *Deepwater Horizon* oil spill. Due to the cold temperature, low nutrient concentrations, contaminated sediments, and slow metabolic rates of deep-sea benthic organisms, recovery to pre-spill conditions is anticipated to take decades or longer in the affected areas (Montagna et al., 2013).

The biodegradation of oil from the *Deepwater Horizon* oil spill on the seafloor was greater farther from the wellhead (6 km; 3.7 mi) than closer (2 km; 1.2 mi), likely due to the higher concentration of oil deposited on the seafloor closer to the wellhead. The concentrations of total *n*-alkanes (hydrocarbon chains) and total PAH's (hydrocarbon rings) were approximately three times higher at a station 2 km (1.2 mi) from the wellhead than they were at a station 6 km (3.7 mi) from the wellhead one year after the spill (Liu et al., 2012). The sediment was more enriched with the larger compounds (both *n*-alkanes and PAH's), indicating the biological degradation of the smaller compounds and biodegradation was more intense at the farther station. The more heavily contaminated site may have had a decreased biodegradation rate as a result of oxygen depletion caused by a combination of reduced oxygen penetration into the sediment by an oil barrier on the sediment surface and the local depletion of dissolved oxygen from bacterial consumption of labile hydrocarbons (Liu et al., 2012). The smaller compounds are easier for the bacteria to break down, leaving the sediment enriched in the larger compounds; however, labile *n*-alkanes were still present in the sediment 1 year after the spill, indicating that the biodegradation of the oil in sediment is occurring slowly, especially at the more heavily contaminated sites closer to the well (Liu et al., 2012).

Oysters from two separate studies have not shown impacts from the *Deepwater Horizon* oil spill. Oysters that were transplanted before, during, and after the *Deepwater Horizon* oil spill, in areas of Mobile Bay and the Mississippi and Alabama coast that were potentially exposed to oil, did not show evidence of oil-derived C and N in their shells or tissue (Carmichael et al., 2012). This finding indicates that the oysters sampled were either not exposed to oil, did not feed on oiled food sources, or consumed too little oiled food to detect in their shells and tissue. It is also possible that the oysters rapidly depurated any consumed oil or slowed filter feeding due to the stress of oil exposure. Whatever the reason, because oysters did not assimilate oil-derived C and N, they did not provide a contaminated food source to higher trophic levels (Carmichael et al., 2012). In addition, oysters collected from oil exposed areas of Mississippi Sound 6 months after the *Macondo* well was capped did not show PAH accumulation (Soniat et al., 2011). Oyster condition, infection rate, and reproductive state were no different from oysters sampled from areas not exposed to oil. Both oyster studies caution, however, that sample sizes were small and the findings of the study should not be extrapolated to all oysters in the GOM. Nonetheless, the results indicate that oysters in the CPA should not have accumulated PAH or assimilated oil-derived C or N from the *Deepwater Horizon* oil spill either.

Many deepwater soft bottom benthic sites have been sampled by NRDA through visual documentation and sediment coring to assess the adverse effects of dispersed oil and drilling mud from the *Deepwater Horizon* explosion, oil spill, and response on these habitats. The information collected at site-specific locations will be used to model the extent of oiling in deepwater sediments (USDOC, NOAA, 2012a). This information has yet to be released.

Limited data are currently available on potential impacts of the *Deepwater Horizon* explosion, oil spill, and response on the soft bottom benthic communities in the CPA. This incomplete or unavailable information may be relevant to reasonably foreseeable significant impacts to soft bottom benthic communities. Relevant data on the status of soft bottom benthic communities after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze. Much of these data are being developed through the NRDA process, which may take years to complete. Little data from the NRDA process have been made available to date. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. BOEM has determined that this incomplete or unavailable information may be essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. In the place of this incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches.

4.1.1.12. Marine Mammals

BOEM has reexamined the analysis for marine mammals presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for marine mammals presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

A detailed description of marine mammals can be found in Chapter 4.2.1.12.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.12 of the WPA 233/CPA 231 Supplemental EIS.

Impacts of Routine and Accidental Events

The routine activities associated with proposed CPA Lease Sales 235, 241, and 247 that would potentially affect marine mammals include the following: the degradation of water quality from operational discharges; noise generated by aircraft, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and marine debris from service vessels and OCS structures. A detailed impact analysis of the routine impacts of proposed CPA Lease Sales 235, 241, and 247 on marine mammals can be found in Chapter 4.2.1.12.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.12 of the WPA 233/CPA 231 Supplemental EIS.

Some routine activities related to a CPA proposed action have the potential to have adverse, but not significant, impacts to marine mammal populations in the GOM. Impacts from vessel traffic, structure removals, and seismic activity could negatively impact marine mammals; however, when mitigated as required by BOEM and NMFS, these activities are not expected to have long-term impacts on the size and productivity of any marine mammal species or population. Most other routine activities are expected to have negligible effects.

Impact-producing factors associated with accidental events that may be associated with a CPA proposed action that could affect marine mammals include blowouts, oil spills, and spill-response activities. A detailed impact analysis of the accidental impacts that may be associated with proposed

CPA Lease Sales 235, 241 and 247 on marine mammals can be found in Chapter 4.2.1.12.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.12 of the WPA 233/CPA 231 Supplemental EIS.

Accidental events related to a CPA proposed action have the potential to have adverse, but not significant, impacts to marine mammal populations in the Gulf of Mexico. Accidental blowouts, oil spills, and spill-response activities may impact marine mammals in the Gulf of Mexico. 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.

Oil spills may cause chronic (long-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on marine mammals. Long-term effects include decreases in prey availability and abundance because of increased mortality rates, change in age-class population structure because certain year-classes were impacted more by oil, decreased reproductive rate, and increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). The 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.

Even after the spill is stopped, oiling or deaths of marine mammals could still occur due to oil and dispersants persisting in the water, past marine mammal/oil or dispersant interactions, and ingestion of contaminated prey. The animals' exposure to hydrocarbons persisting in the sea may result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; behavioral effects; and increased vulnerability to disease) and some soft tissue irritation, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats.

Summary and Conclusion

BOEM has reexamined the analysis for marine mammals presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for marine mammals presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because of the available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sale 235, 241, and 247.

Cumulative Impacts

Background/Introduction

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 CPA proposed action. The major potential impact-producing factors affecting protected marine mammals in the GOM as a result of cumulative OCS oil- and gas-related activities include marine debris, contaminant spills and spill-response activities, vessel traffic, noise, seismic surveys, and explosive structure removals. Non-OCS oil- and gas-related activities that may affect marine mammal populations include vessel traffic and related noise (including from commercial shipping and research vessels), military operations, commercial fishing, pollution, 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.

OCS Oil- and Gas-Related Activities

The major impact-producing factors relative to a CPA proposed action are described below and in Chapter 4.2.1.12 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.12 of the WPA 233/CPA 231 Supplemental EIS. Chapters providing supportive material for the marine mammals analysis include Chapter 4.1.1.12 (description of marine mammals) of the 2012-

2017 WPA/CPA Multisale EIS, updated information provided in Chapter 4.1.1.12 of the WPA 233/CPA 231 Supplemental EIS, and **Chapters 3.1.1.2** (exploration and delineation), **3.1.1.3** (development and production), **3.1.1.6** (noise), **3.1.2.1** (coastal impact-producing factors and scenario), and **3.2.1** (oil spills) of this Supplemental EIS. This Agency completed a Programmatic EA on G&G permit activities in the GOM (USDOI, MMS, 2004). The Programmatic EA includes a detailed description of the seismic surveying technologies, energy output, and operations, and it 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 functions could have impacts on individuals and populations. The OCS oil and gas industry's operations contribute noise to the marine environment from several different operations. As noted below and in Chapter 4.2.1.12.2 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.12 of the WPA 233/CPA 231 Supplemental EIS, it is believed that most of the oil and gas 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 3.1.1.6** discusses the expected sources of many of these impacts for the OCS Program, as well as the expected sources from past, present, and future OCS oil and gas industry operations. Many other sources also contribute to the overall noise in the GOM. The dominant source of human sound in the sea is ship noise (Tyack, 2008). Both the noise from the vessel's operation as well as the potential for ship strikes could potentially impact marine mammals. 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). The intensity of noise from oil and gas industry 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. The GOM is a very active shipping area and supertankers are very common. Of the 10 busiest ports in the United States, 7 are located in the Gulf of Mexico (USEPA, 2011e). Industry service boats are numerous and are expected to make 3,310-4,382 round trips in the GOM per year. Service vessels are a large contributor 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.

BOEM and BSEE issued NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which provides guidance for vessel strike avoidance and reporting. This guidance should minimize the chance of marine mammals being subject to the increased noise level of an oil and gas 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 approximately 1 million helicopter take offs/landings expected per year from activity related to past, proposed, and future lease sales, OCS oil and gas industry activity contributes greatly to this noise source. Although air traffic well offshore is limited, flight level minimum guidelines from NOAA and corporate helicopter policy should help mitigate the industry-related flight noise, although 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.

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 a CPA 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. BOEM and BSEE issued

NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which provides guidance for vessel strike avoidance and reporting in order to minimize the harassment of mammals by vessels approaching too closely. It also provides for the reporting of injured or dead protected species. Although OCS oil- and gas-related 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.

The OCS oil and gas industry drilling impacts are discussed in **Chapter 3.1.1**. 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. In 2005, this Agency petitioned NMFS for incidental-take regulations under the MMPA to address the potential injury and/or mortality of marine mammals that could result from the use of explosives during decommissioning activities. Similarly, this Agency initiated ESA section 7 consultation efforts with NMFS to cover potential explosive-severance impacts to threatened and endangered species such as sperm whales (and sea turtles). The consultation was completed in August 2006, and the final MMPA take rule was published in June 2008 (*Federal Register* (2008a). The mitigation, monitoring, and reporting requirements from the current ESA Biological Opinion/Incidental Take Statement and MMPA regulations mirror one another and allow explosive charges up to 500 lb (227 kg), internal and external placement, and both above-mudline and below-mudline detonations. The BOEMRE issued "Decommissioning Guidance for Wells and Platforms" (NTL 2010-G05) to offshore operators. This guidance specifies and references mitigation requirements in the new ESA and MMPA guidance and require trained observers to watch for protected species of sea turtles and marine mammals in the vicinity of the structures to be removed.

Seismic exploration is the source of the loudest, and perhaps most controversial, OCS oil and gas industry activity. Details on seismic impacts on marine mammals are given in the Chapter 4.2.1.12.2 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.12 of the WPA 233/CPA 231 Supplemental EIS, and complete information is included in the G&G Programmatic 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. Although there are anecdotal associations between marine 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. In 2003, NMFS published a notice of receipt of application for an incidental take authorization from this Agency, requesting comments and information on taking marine mammals incidental to conducting oil and gas exploration activities in the GOM (*Federal Register*, 2003). In 2004, NMFS published a notice of intent to prepare an EIS, notice of public meetings, and request for scoping comments for the requested authorizations (*Federal Register*, 2004). In April 2011, NMFS received a revised complete application from this Agency requesting an authorization for the take of marine mammals incidental to seismic surveys on the OCS in the GOM (*Federal Register*, 2011a). The National Marine Fisheries Service's EIS has not been completed at this time. In response to terms and conditions in NMFS's Biological Opinion for Lease Sale 184 in 2002, this Agency 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 4.2.1.12.1 of the 2012-2017 WPA/CPA Multisale EIS, current research by BOEM and partners did not detect avoidance of seismic vessels or airguns by sperm whales. Although that 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. Even with additional ongoing research, such changes in species abundance and distribution due to seismic disturbances would likely be very difficult to establish on a small scale. For the sperm whale, the most recent abundance for the GOM population was estimated to be 763 individuals (Waring et al., 2013). Research has shown that sperm whales are distributed throughout the deeper waters of the northern GOM, not primarily in Mississippi Canyon as previously thought. With seismic surveys frequently conducted in the GOM, it is likely that there are few naive sperm whales (those that have not been exposed to seismic sound) in the northern Gulf. The GOM sperm whales have generally been smaller than sperm whales in other areas, and genetic research indicates a distinct stock or population that is almost exclusively females and immature males; mature males are thought to move into and out of the GOM. Observations of adult males are uncommon in the GOM (<10), yet calves are seen regularly. Reproduction is occurring in a highly industrialized environment, although stress, particularly at the individual animal level, is difficult to observe and measure. 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 satellite tag (s-tag) that allow the tracking of individual whales, and sometimes several individuals in a group, over the span of weeks and months may provide information on behavioral changes, as well as learning what is "typical" whale behavior.

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 3.1.1.4**. Effluents are routinely discharged into offshore waters and are regulated by the U.S. Environmental Protection Agency's NPDES permits. Marine mammals may be periodically 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 oil and gas industry form of pollution is accidental oil spills. Impacts of these accidental events to marine mammals are discussed below and in Chapter 4.2.1.12.3 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.12 of the WPA 233/CPA 231 Supplemental EIS.

Marine debris is a serious concern in the ocean environment. 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 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. 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. Sheavely (2007) reports that as much as 49 percent of marine debris is considered land-based. 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 has greatly improved waste handling. More efficient gear packaging and better galley practices have significantly reduced the amount of waste generated offshore. The BSEE 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. BOEM provides information on marine debris and awareness and requires training of all OCS personnel through the "Marine Trash and Debris Awareness and Elimination" NTL (NTL 2012-BSEE-G01).

In 2010, the *Deepwater Horizon* explosion occurred in Mississippi Canyon Block 252, and the resulting oil spill and related spill-response activities (including use of dispersants) have impacted marine mammals that have come into contact with oil and remediation efforts. According to NMFS's website reports on stranded marine mammals during and after the *Deepwater Horizon* explosion, oil spill, and response, 171 marine mammals (the majority of which were deceased) have been collected as of April 17, 2011 (USDOC, NMFS, 2013a). All marine mammals collected either alive or dead were found east of the Louisiana/Texas border. A recent study conducted as part of the NRDA process found strong evidence of petroleum hydrocarbon exposure and toxicity, some expected to result in death, in common bottlenose dolphins in Barataria Bay, Louisiana, an area that was heavily oiled during the *Deepwater Horizon* explosion and oil spill, as compared with common bottlenose dolphins in Sarasota Bay, Florida (Schwacke et al., 2013). Advances in oil-spill prevention technologies and safety requirements should greatly reduce 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 in most situations. 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, although these are usually small. Even natural seeps on the floor of the GOM can result in an oil slick or sheen on the surface (NRC, 2003).

An unusual mortality event (UME) is defined in the MMPA as “a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response.” The UME’s appear to be triggered by natural events (i.e., unusually cold weather and disease) but others are suspected to at least be indirectly caused by pollution of various contaminants. It is unclear at this time whether the UME occurring in the GOM is related partially, wholly, or not at all to the *Deepwater Horizon* explosion, oil spill, and response. According to NMFS’s website referenced above, which is the only publicly available source of information at this time on the UME, evidence of the UME was first documented by NMFS as early as February 2010, several months prior to the *Deepwater Horizon* explosion, oil spill, and response. However, the current data (**Table 4-1**) also show a marked increase in strandings during the *Deepwater Horizon* explosion, oil spill, and response and afterwards. According to the website, NMFS considers the investigation into the cause of the UME and the potential role of the *Deepwater Horizon* explosion, oil spill, and response to be “ongoing and no definitive cause has yet been identified for the increase in cetacean strandings in the northern Gulf in 2010 and 2011.” It is therefore unclear whether increases in stranded cetaceans during and after the *Deepwater Horizon* explosion, oil spill, and response period are or are not related to impacts from the *Deepwater Horizon* explosion, oil spill, and response and will likely remain unclear until NMFS completes its UME and NRDA evaluation processes.

Non-OCS Oil- and Gas-Related Activities

Non-OCS oil- and gas-related activities that may affect marine mammal populations include vessel traffic and related noise (including from commercial shipping, research vessels), military operations, commercial fishing, pollution, scientific research, and natural phenomena.

Other groups such as the military (U.S. Navy and USCG) and other Federal agencies (USEPA, COE, and NMFS), dredges, commercial fishermen, and recreational boaters operate vessels and contribute to the ambient noise in the Gulf. The COE also engages in some explosive and pile-driving operations that create loud but temporary noise. Such COE activities are consulted on with NMFS, and mitigations are included, often similar to the mitigations employed by BOEM in consultation with NMFS. Although air traffic well offshore is limited, the military maintains 11 military warning areas and 6 water test areas in the Gulf (**Figure 2-2**). Some commercial fisheries include aerial surveillance. Scientific research aerial surveys are occasionally scheduled over the GOM. Commercial and private aircraft also traverse the area. State oil and gas activities (**Chapter 3.3.2)** also create drilling and associated noise, particularly in Texas and Louisiana State waters. These effects are similar to those of OCS oil and gas operations discussed above.

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. 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 (platforms) in the deep waters of the Gulf may indirectly be encouraging these interactions. Recreational fishing vessels go much farther out to get to the improved fishing at OCS oil and gas structures. 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.

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 caught on longline hooks or can be entrained 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.

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 discharged 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). Since most of the marine mammals in the Gulf are oceanic dwellers that have the ability to alter their course depending on the surroundings, 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 may impact 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 that scratch on the hulls of vessels, areas with high concentrations of vessels may have extremely polluted waters.

Marine debris from non-OCS oil- and gas-related sources also has the potential to impact marine mammals. These impacts would not be different from those described above for OCS oil- and gas-related sources.

Scientific research can impact marine mammal species. BOEM 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. In 2011, a scientific cruise that was associated with NRDA killed six dolphins while sampling fish with nets. Scientific aerial surveys are also periodically conducted in the Gulf, and aircraft can startle marine 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 U.S. 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.

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 contaminants. Exposure to certain compounds may weaken the natural immunity of marine mammals and make them susceptible to viruses and diseases that would normally not affect them. Certain viruses are being observed more frequently than in the past. A UME is defined under the MMPA as a "stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response." Several UME's have been declared since 2010 in the Gulf of Mexico. Some potential causes have been determined and an UME may have devastating effects on a marine mammal population depending on its extent and duration. More detail on UME's can be found on NMFS's website at http://www.nmfs.noaa.gov/pr/health/mmume/ (USDOC, NMFS, 2014a).

Tropical storms and hurricanes are normal occurrences in the Gulf and along the coast. Generally, the impacts have been localized and infrequent. However, during the past 10 years, the GOM has been hit extremely hard by very powerful hurricanes. Few areas of the coast had 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, and these hurricanes were followed in 2008 by Hurricane Gustav. 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

Cumulative impacts on marine mammals are expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS oil- and gas-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 (Harvey and Dahlheim, 1994). Disturbance (noise from vessel traffic and drilling operations) 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 (Harvey and Dahlheim, 1994). The net result of any disturbance will depend 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). As discussed in **Appendix B**, a low-probability catastrophic event could have population-level effects on marine mammals.

The effects of a CPA proposed action, when viewed in light of the effects associated with other past, present, and reasonably foreseeable future activities, may result in greater impacts to marine mammals than before the *Deepwater Horizon* explosion, oil spill, and response; however, the magnitude of those effects cannot yet be determined. Nonetheless, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTL's, to minimize these potential interactions and impacts. The operator's reaffirmed compliance with NTL 2012-JOINT-G01 ("Vessel Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2012-BSEE-G01 ("Marine Trash and Debris Awareness and Elimination"), as well as the limited scope, timing, and geographic location of a CPA proposed action, would result in negligible effects from the proposed drilling activities on marine mammals. In addition, NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimizes the potential of harm from seismic operations to marine mammals. These mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source. Therefore, no significant cumulative impacts to marine mammals would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area.

Unavailable information on the effects to marine mammals from the UME and *Deepwater Horizon* explosion, oil spill, and response (and thus, changes to the marine mammal baseline in the affected environment) makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to marine mammals. Relevant data on the status of marine mammal populations after the UME and *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. For example, even 20 years after the *Exxon Valdez* spill, the long-term impacts to marine mammal populations are still being investigated (Matkin et al., 2008). Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis applied using accepted scientific methods and approaches. Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this Supplemental EIS (including the No Action and Action alternatives) for the three main reasons listed below.

(1) The CPA is an active oil and gas region with ongoing (or the potential for) exploration, drilling, and production activities. The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this Supplemental EIS. Impacts on marine mammals from either smaller accidental events or low-probability catastrophic events will remain the same.

(2) Some marine mammal populations in the CPA do not generally travel throughout areas affected by spilled oil from the Deepwater Horizon explosion, oil spill, and response, and they would not be subject to a changed baseline or cumulative effects from the Deepwater Horizon explosion, oil spill, and response (e.g., coastal bottlenose dolphins resident in the CPA). Other marine mammals, such as Bryde's whales and manatees, although potentially affected by the Deepwater Horizon explosion, oil spill, and response do not typically occur in the CPA.

(3) Other wide-ranging populations of marine mammals (e.g., sperm whales and killer whales) that may occur in the GOM and within areas affected by the spill are unlikely to have experienced population-level effects from the *Deepwater Horizon* explosion, oil spill, and response given their wide-ranging distribution and behaviors.

Within the GOM, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting marine mammal populations. Therefore, in light of the above analysis for a CPA proposed action and its impacts, the incremental effect of a CPA proposed action on marine mammal populations is not expected to be significant when compared with non-OCS energy-related activities.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources (NOAA's websites and the RestoreTheGulf.gov website), as well as recently published journal articles was conducted to determine the availability of recent information on marine mammals.

On December 13, 2010, NMFS declared an UME for cetaceans (whales and dolphins) in the Gulf of Mexico. An UME is defined under the Marine Mammal Protection Act as a "stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response." Evidence of the UME was first noted by NMFS as early as February 2010, before the *Deepwater Horizon* explosion, oil spill, and response. As of February 2, 2014, a total of 1,086 cetaceans (6% stranded alive and 94% stranded dead) have stranded since the start of the UME, with a vast majority of these strandings between Franklin County, Florida, and the Louisiana/Texas border. After the initial response phase ended, six dolphins were killed incidental to fish-related scientific data collection and one dolphin was killed incidental to trawl relocation for a dredging project. More detail on the UME can be found on NMFS's website (USDOC, NMFS, 2014a).

In addition to investigating all other potential causes, scientists are investigating what role *Brucella* may have played in the UME and this continues today. As of June 30, 2013, 27 out of 107 dolphins tested to date were positive or suspect positive for *Brucella*. *Brucella* spp. refers to a genus of bacteria that infect many terrestrial and aquatic vertebrates around the world. The disease, called brucellosis, is best known for its role in causing abortion in domestic livestock and undulant fever in people. The total deaths for just one of the cetaceans, the bottlenose dolphin, currently well exceed the Potential Biological Removal. (The Potential Biological Removal is the product of minimum population size, one-half the maximum net productivity rate, and a recovery factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population [Waring et al., 2013]). It is unclear at this time whether the increase in strandings is related partially, wholly, or not at all to the *Deepwater Horizon* explosion, oil spill, and response. The NMFS has documented 25 UME's (17 of which involved cetaceans; the remaining 8 were specific to manatees only) that have occurred in the GOM for cetaceans since 1991.

According to their website, NMFS considers the investigation into the cause of the UME and the potential role of the *Deepwater Horizon* explosion, oil spill, and response to be "ongoing and no definitive cause has yet been identified for the increase in cetacean strandings in the northern Gulf from 2010 to the present." It is therefore unclear whether increases in stranded cetaceans during and after the *Deepwater Horizon* explosion, oil spill, and response period are or are not related to impacts from the *Deepwater Horizon* explosion, oil spill, and response, and it will likely remain unclear until NMFS completes its UME and NRDA evaluation processes.

On May 9, 2012, NOAA declared an UME for bottlenose dolphins in five Texas counties (UME No. 56). The UME lasted from November 2011 through March 2012, when 123 bottlenose dolphins stranded in Aransas, Calhoun, Kleberg, Galveston, and Brazoria Counties in Texas. Of the 123 animals stranded, only 4 were found alive. Preliminary findings included infection in the lung, poor body condition, and discoloration of the teeth; in four animals, a black/grey, thick mud-like substance in the stomachs was found. The strandings were coincident with a harmful algal bloom of *Karenia brevis* that started in September 2011 in southern Texas, but researchers have not determined that was the cause of the event. Currently, there are no red tide blooms occurring in the region, and stranding rates have returned to normal levels (USDOC, NMFS, 2013b).

As of October 3, 2013, a red-tide event in southwest Florida has claimed 288 manatees since first detecting the red tide bloom in late September 2012. Although results are preliminary, this is the highest number of red tide-related deaths in a single calendar year on record. State and Federal scientists are monitoring and responding to manatees affected by the ongoing red tide bloom along the southwest Florida coast (State of Florida, Fish and Wildlife Conservation Commission, 2013). Research into the causes of these deaths is currently ongoing and undetermined for UME No. 58 (Florida). A previous UME in 2011 (No. 52) was caused by ecological factors. A UME (No. 59) was declared in January 2013 for bottlenose dolphins on the East Coast of Florida, the cause of which is still undetermined. Necropsies performed found most of the dolphins were emaciated and the timing coincided with the West Coast's red tide-caused UME of manatees. There have been three separate manatee sitings near oil rigs in the CPA in water depths as great as 1,828 m (6,000 ft) (Epperson, official communication, 2013). Per the guidance provided in NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protection Species Reporting," an operator is to report an observation of an injured or dead protected species.

The final determinations on damages to marine mammal resources from the *Deepwater Horizon* explosion, oil spill, and response will ultimately be made through the NRDA process. The *Deepwater Horizon* explosion, oil spill, and response will ultimately allow a better understanding of any realized effects from such a low-probability catastrophic spill. However, the best available information on impacts to marine mammals does not yet provide a complete understanding of the effects of the oil spill and active response/cleanup activities from the *Deepwater Horizon* explosion, oil spill, and response on marine mammals as a whole in the GOM and whether these impacts reach a population level. For example, although there has been a study published from the NRDA process regarding the possible effects from the *Deepwater Horizon* oil spill on Barataria Bay bottlenose dolphins, there were no effects detected on the Sarasota Bay bottlenose dolphins; therefore, it would be difficult to use this information to conclude anything different for the overall bottlenose dolphin population in the GOM (Schwacke et al., 2013). There is also an incomplete understanding of the potential for population-level impacts from the ongoing UME.

Here, BOEM concludes that the unavailable information from these events may be relevant but not necessarily essential to reasonably foreseeable significant adverse impacts to marine mammals. In some specific cases, such as with bottlenose dolphins as noted below, the unavailable information may also be relevant to a reasoned choice among the alternatives based on the discussion below. The cost of obtaining data on the effects from the UME and/or *Deepwater Horizon* explosion, oil spill, and response are exorbitant; duplicative of efforts already being undertaken as part of the UME and NRDA; and would likewise take years to acquire and analyze through the existing NRDA and UME processes. Further, impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. For example, even 20 years after the *Exxon Valdez* spill, long-term impacts to marine mammal populations were still being investigated (Matkin et al., 2008). Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches. The 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, and EPA 225/226 EIS (USDOI, BOEM, 2013b) have further details on sperm whales, Bryde's whales, bottlenose dolphins, and manatees.

4.1.1.13. Sea Turtles

BOEM has reexamined the analysis for sea turtles presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for sea turtles presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

A detailed description of loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles can be found in Chapter 4.2.1.13.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.13 of the WPA 233/CPA 231 Supplemental EIS. The FWS and NMFS share Federal jurisdiction for sea turtles under the ESA. The FWS has responsibility for sea turtles (i.e., eggs, hatchlings, and nesting turtles) on the nesting beaches. The NMFS has jurisdiction for sea turtles in the marine environment.

Impacts of Routine and Accidental Events

The routine activities associated with proposed CPA Lease Sales 235, 241, and 247 that would potentially affect sea turtles include the following: the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, drillships, and seismic exploration; vessel collisions; and marine debris generated by service vessels and OCS oil- and gas-related facilities. A detailed impact analysis of the routine impacts of proposed CPA Lease Sales 235, 241, and 247 on sea turtles can be found in Chapter 4.2.1.13.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.13 of the WPA 233/CPA 231 Supplemental EIS.

Because of the mitigations (e.g., BOEM and BSEE proposed compliance with NTL's) discussed in the 2012-2017 WPA/CPA Multisale EIS, routine activities (e.g., operational discharges, noise, vessel traffic, and marine debris) related to a CPA proposed action are not expected to have long-term adverse effects on the size and productivity of any sea turtle species or populations in the northern Gulf of Mexico. Lethal effects could occur from chance collisions with OCS oil- and gas-related service vessels or ingestion of accidentally released plastic materials from OCS vessels and facilities. However, there have been no reports to date on such incidences. Most routine OCS oil- and gas-related activities are expected to have sublethal effects that are not anticipated to rise to the level of significance.

Impact-producing factors associated with accidental events that may be associated with a CPA proposed action that could affect sea turtles include blowouts, oil spills, and spill-response activities. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on sea turtles can be found in Chapter 4.2.1.13.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.13 of the WPA 233/CPA 231 Supplemental EIS.

Accidental blowouts, oil spills, and spill-response activities resulting from a CPA 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. Impacts on sea turtles from smaller accidental events are likely to affect individual sea turtles in the area, but they are unlikely to rise to the level of population effects (or significance) given the size and scope of such spills. Further, the potential remains for smaller accidental spills to occur in a CPA proposed action area, regardless of any alternative selected under this Supplemental EIS, given that it is an active oil and gas region with either ongoing or the potential for exploration, drilling, and production activities.

Summary and Conclusion

BOEM has reexamined the analysis for sea turtles presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for sea turtles presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because of the available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

This cumulative analysis considers the effects of impact-producing factors related to a CPA 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 a CPA proposed actions.

OCS Oil- and Gas-Related Impacts

The major impact-producing factors resulting from cumulative OCS oil- and gas-related activities associated with a CPA proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles and their habitats include marine debris, contaminant spills and spill-response activities, vessel traffic, noise, seismic surveys, and explosive structure removals. Major impact-producing factors related to a CPA proposed action that may occur are reviewed in detail in **Chapter 4.1.1.13**. Chapters providing supporting material for the sea turtle analysis include **Chapters 4.1.1.1** (air quality), **4.1.1.2.1** and **4.1.1.2.2** (water quality), **4.1.1.3** (coastal barrier beaches and associated dunes), **4.1.1.5** (seagrass communities), **3.1.1** (offshore impact-producing factors and scenario), **3.1.2** (coastal impact-producing factors and scenario), **3.2** (impact-producing factors and scenario—accidental events), **3.3** (cumulative activities scenario), and **5.7** (Endangered Species Act). The cumulative impact of these ongoing OCS oil- and gas-related activities on sea turtles is expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS oil- and gas-related contaminants or discarded debris) because these activities may stress and/or weaken individuals of a local group or population and may predispose them to infection from natural or anthropogenic sources.

Marine Debris

Sea turtles may be impacted by marine debris, whatever its source. 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). While non-OCS oil- and gas-related monofilament debris is the most common entanglement debris, 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 (refer to **Chapter 4.1.1.8** for *Sargassum* impacts). 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. A recent literature and data synthesis by Schuyler et al. (2013) found that smaller individuals in the oceanic life stage are more likely to ingest debris than are individuals foraging in coastal areas; likewise, species that feed primarily on plants or gelatinous zooplankton ("jellyfish") are more likely to ingest debris than carnivorous species. Ingestion of plastics sometimes interferes with food passage, respiration, and buoyancy and could reduce the fitness of a turtle or result in death (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; Lutz and Alfaro-Shulman, 1992). The BSEE regulate the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR § 250.300). In addition, MARPOL Annex V (P.L. 100-220; 101 Statute 1458) prohibits the disposal of plastics at sea or in coastal waters.

The BSEE proposes compliance with the guidance provided in NTL 2012-BSEE-G01, "Marine Trash and Debris Awareness and Elimination," which should appreciably reduce the likelihood of sea turtles encountering marine debris from the proposed activity.

Effluents are routinely discharged into offshore waters and are regulated by the U.S. Environmental Protection Agency's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and, due to USEPA's 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 trophic system, which may kill or debilitate important prey species of sea turtles or lower trophic level species. This could ultimately reduce reproductive fitness or survival in individual sea turtles.

Coastal Infrastructure and Pipelines

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). Sea turtles, primarily loggerheads, in the GOM are known to occur regularly within the vicinity of oil and gas platforms (Hart et al., 2013). These structures provide habitat and foraging opportunities for subadult and adult sea turtles, which may enhance the recovery of some turtle populations.

Pollution

Since sea turtle habitat in the Gulf includes both inshore and offshore areas, sea turtles are likely to encounter spills that may be related to OCS oil- and gas-related development activities or other sources. 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 2012 to 2050 (Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS). 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. 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 habitat disturbances may be temporary, chronic exposure to or ingestion of oil may result in illness or depressed fitness. Hatchling and juvenile turtles are particularly vulnerable to contacting or ingesting oil because currents that concentrate oil spills also form aggregates of *Sargassum* and other floating material that provide habitat 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 prolong their contact with viscous weathered oil that becomes concentrated in these zones (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 I* 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. Oil fouling of a nesting area may disturb the 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 is dependent on 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 and 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). Due to 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. Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B**.

Vessel Strikes

Sea turtles must surface to breathe and may spend time at the surface for a variety of life-history functions. Collisions between service vessels or barges and sea turtles would likely cause fatal injury to the sea turtle. The speed of the vessel is correlated to the likelihood of strike; turtles are less likely to actively avoid or respond to the approach of a vessel moving at higher speeds (Hazel et al. 2007). Vessel traffic, particularly supply boats running from shore bases to offshore structures, is one of the industry activities included in a CPA proposed action. It is projected that 70,725-90,675 OCS oil- and gas-related, service-vessel round trips would occur annually in support of OCS oil- and gas-related activities in the CPA (Table 3-4). In the entire OCS, 82,750-109,550 service-vessel trips would occur annually (Table 3-3). It is important to note that these numbers take into account all of the activities projected to occur from past, proposed, and future lease sales. In response to the terms and conditions of previous NMFS's Biological Opinions, and in an effort to further minimize the potential for vessel strikes, BOEM and BSEE issued NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which clarifies 30 CFR § 550.282 and 30 CFR § 250.282 and provides NMFS guidelines for monitoring procedures related to vessel strike avoidance measures for sea turtles and other protected species.

Increased vessel traffic in the GOM 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 GOM. Potential adverse effects from Federal vessel operations in the CPA proposed action area include operations of the U.S. Navy and USCG, which maintain the largest Federal vessel fleets; USEPA; NOAA; and COE. The NMFS has conducted formal consultations with USCG, U.S. Navy, NOAA, and other Federal agencies, including BOEM, on the activities of their vessels or the vessels considered part of any permitted activity. The NMFS 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 CPA proposed action area. Thus, operations of vessels by Federal agencies within the CPA proposed action area (i.e., U.S. Navy, 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. (The NMFS reported in 2002 that, at that time, there were 14 active scientific research permits for sea turtles.)

Noise

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 594,500-1,112,500 OCS oil- and gas-related helicopter operations (take-offs and landings) would occur annually in the support of OCS oil- and gas-related in the CPA (**Table 3-4**). In the entre OCS, 717,750-1,376,625 helicopter trips would occur annually (**Table 3-3**). The Federal Aviation Administration's Advisory Circular 91-36D (September 17, 2004) encourages pilots to maintain higher than minimum altitudes over noise-sensitive areas. The OCS oil- and gas-related helicopters are not the only aircraft that fly over the coastal and offshore areas.

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. Loggerhead sea turtles in the Mediterranean Sea showed a startle response associated with airgun operation, with 57 percent of observed individuals diving upon or before reaching the airgun array. Of the observed individuals, 7 percent dove immediately after the airgun shot (DeRuiter and Doukara, 2012). Seismic activities are expected to be primarily an 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 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," which minimizes the potential of harm from seismic operations to sea turtles. These mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source.

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.

Explosive discharges, such as those used for BSEE 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 707-1,006 explosive structure removals are projected to occur in the CPA between 2012 and 2051 (**Table 3-4**).

To minimize the likelihood of removals occurring when sea turtles may be nearby, BSEE 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 (NMFS's Observer Program and daylight-only demolition) in place, the "take" of sea turtles during structure removals has been limited. This Agency published a Programmatic EA on decommissioning operations (USDOI, MMS, 2005) that, in part, addresses the potential impacts of explosive and nonexplosive severance activities on OCS oil- and gas-related resources, particularly upon marine mammals and sea turtles. Pursuant to 30 CFR part 250 subpart Q, operators must obtain a permit from BSEE before beginning any platform removal or well-severance activities. During the review of the permit applications, terms and conditions of the August 2007 NMFS Biological Opinion/Incidental Take Statement are implemented for the protection of marine protected species and to reduce the possible impacts from any potential activities resulting from a CPA proposed action.

In 30 CFR part 250 subpart B, BSEE requires operators of Federal oil and gas leases to meet the requirements of the ESA. The regulation outlines the environmental, monitoring, and mitigation information that operators must submit with plans for exploration, development, and production. This regulation requires OCS oil- and gas-related activities to be conducted in a manner that is consistent with the provisions of the ESA. Actual sea turtle impacts from explosive removals in recent years have been small. The updated pre- and post-detonation mitigations should ensure that injuries remain extremely rare. NTL 2010-G05, "Decommissioning Guidance for Wells and Platforms," offers further guidance.

Non-OCS Oil and Gas-Related Activities

Non-OCS oil- and gas-related activities that may affect sea turtle populations include State oil and gas activities, vessel traffic and related noise (including from commercial shipping, research vessels), military operations, commercial fishing, and pollution. Non-OCS oil- and gas-related related activities include historic overexploitation, commercial fishery interactions, habitat loss, dredging, pollution, vessel strikes, and pathogens. The Gulf Coast is a well-populated and growing area, and development of previously unusable land for residential and commercial purposes is common. Recreational boating and watercraft use may threaten individuals and their habitat. Increased human 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.

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 with 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 sediment disposal, 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; NMFS 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.

BOEM has evaluated the use of sand resources for levee, beach, and barrier island restoration projects. Between 1995 and 2013, this Agency provided over 77 million cubic yards of OCS sand for 42 coastal projects, restoring over 370 km (230 mi) 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's 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 decade (U.S. Dept. of the Army, COE, 2004). Use of these resources will require coordination with BOEM for appropriate noncompetitive negotiated agreements. Sea turtles are included in the potential impacts identified for sand dredging projects under analyses and consultations that are separate from this Supplemental EIS. Based on the outcomes of these, required mitigating measures are included as stipulations in the negotiated agreements 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 (polychlorinated biphenyls) and DDE (dichloro-diphenyldichloro-ethylene) 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.

The OCS oil- and gas-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 Dept. of Defense for conducting various air-to-air and air-to-surface operations. Eleven military warning areas and six water test areas are located within the Gulf, as stated in NTL 2009-G06, "Military Warning and Water Test Areas" (**Figure 2-1**). Additional activities, including vessel operations and ordnance detonation, also may affect sea turtles. Private and commercial air traffic also traverse these areas and have the potential to cause impacts to 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, NMFS, 2002). Monofilament line was reported as 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).

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 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 NMFS has required the use of turtle excluder devices 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, NMFS increased enforcement efforts (relative to turtle excluder devices), which decreased the number of strandings. After concerns arose that turtle excluder devices were not adequately protecting larger sea turtles, NMFS 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 shrimp trawls. The Biological Opinion also stated that 75 percent of the loggerhead sea turtles in the GOM were too large to be protected by the turtle excluder devices. Subsequent regulation issued by NMFS in 2003 required larger openings to better protect the larger sea turtles. The use of turtle excluder devices is believed to reduce hard-shelled sea turtle captures by 97 percent. Even so, NMFS estimated that 4,100 turtles may be captured annually by shrimp trawling, including 650 leatherbacks that cannot be released through turtle excluder devices, 1,700 turtles taken in nets, and 1,750 turtles that fail to escape through the turtle excluder devices. 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 (De Silva, 1998).

Coastal habitats such as algae and seagrass beds are frequented by sea turtles seeking food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980). 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 turtle nests 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 is 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 loggerhead hatchling production on the southern half of Hutchinson Island (Martin, 1996). A beach can be completely unavailable 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). The number of false crawls (i.e., a nesting attempt) for hawksbill turtles increased significantly 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 the 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.

Summary and Conclusion

As described above, few deaths are expected from chance collisions with OCS oil- and gas-related service vessels, ingestion of plastic material, commercial fishing, and pathogens. Disturbance (noise from vessel traffic and drilling operations) 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 during their life cycle. The net result of any disturbance depends 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). As discussed above, lease stipulations and regulations are in place to reduce vessel strike mortalities. As discussed in **Appendix B**, a low-probability catastrophic event could have population-level effects on sea turtles.

The effects of a CPA proposed action, when viewed in light of the effects associated with other past, present, and reasonably foreseeable future activities, may result in greater impacts to sea turtles than before the *Deepwater Horizon* explosion, oil spill, and response; however, the magnitude of those effects cannot yet be determined. Nonetheless, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTL's, to minimize these potential interactions and impacts. The operator's reaffirmed compliance with NTL 2012-JOINT-G01 ("Vessel Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2012-BSEE-G01 ("Marine Trash and Debris Awareness Elimination"), as well as the limited scope, timing, and geographic location of a CPA proposed action, would result in negligible effects from the proposed drilling activities on sea turtles. In addition, NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimizes the potential of harm from seismic operations to sea turtles and marine mammals; these mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source. Therefore, no significant cumulative impacts to sea turtles would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area.

Adverse effects may result from the incremental contribution of a CPA proposed action combined with non-OCS oil- and gas-related activities. The biological significance of any mortality or adverse impact would depend, in part, on the size and reproductive rates of the affected populations, as well as the number, age, and size of animals affected. However, as the analyses above indicate, the potential for impacts is mainly focused on the individual, and population-level impacts are not anticipated based on the best available information.

Incremental injury effects from a CPA proposed action on sea turtles are expected to be negligible for drilling and vessel noise and minor for vessel collisions but will not rise to the level of significance because of the limited scope, duration, and geographic area of the proposed drilling and vessel activities and the relevant regulatory requirements.

The effects of a CPA proposed action, when viewed in light of the effects associated with other relevant activities, may affect sea turtles occurring in the GOM. With the enforcement of regulatory requirements for drilling and vessel operations and the scope of a CPA proposed action, the incremental effects from the proposed drilling activities on sea turtles will be negligible (drilling and vessel noise) to minor (vessel strikes). The best available scientific information indicates that sea turtles do not rely on acoustics; therefore, vessel noise and related activities would have limited effect. Consequently, no significant cumulative impacts would be expected from a CPA proposed action's activities or as the result of past, present, or reasonably foreseeable oil and gas leasing, exploration, development, and production in the GOM. Even taking into account additional effects resulting from non-OCS oil- and gas-related activities, the potential for impacts from a CPA proposed action is mainly focused on the individual. Population-level impacts are not anticipated based on the best available information.

Within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting sea turtle populations. Therefore, in light of the above analysis of a CPA proposed action and its impacts, the incremental effect of a CPA proposed action on sea turtle populations is not expected to be significant when compared with non-OCS oil- and gas-related activities.

Unavailable information on effects to sea turtles from the *Deepwater Horizon* explosion, oil spill, and response (and thus changes to the sea turtle baseline in the affected environment) makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to sea turtles. Relevant data on the status of sea turtle populations after the *Deepwater Horizon* explosion, oil spill, and response and increased sea turtle GOM strandings may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches. Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this Supplemental EIS (including the No Action and Action Alternatives) for the two main reasons listed below:

(1) The CPA is an active oil and gas region with ongoing (or the potential for) exploration, drilling, and production activities. The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this Supplemental EIS. Impacts on sea turtles from either smaller accidental events or low-probability catastrophic events will remain the same.

(2) All wide-ranging populations of sea turtles that may occur in the CPA and within areas affected by the spill are unlikely to have experienced population-level effects from the *Deepwater Horizon* explosion, oil spill, and response given their wide-ranging distribution and behaviors.

In any event, the incremental contribution of a CPA proposed action would not be likely to result in a significant incremental impact on sea turtles within the CPA; in comparison, non-OCS oil- and gas-related activities such as overexploitation, commercial fishing, and pollution have historically proved to be of greater threat to the sea turtle species.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources (NOAA's and FWS's websites, and the RestoreTheGulf.gov website), as well as recently published journal articles was conducted to determine the availability of recent information on sea turtles.

The loggerhead sea turtle was listed as a threatened species on July 28, 1978 (*Federal Register*, 1978). In 2011, NMFS and FWS listed nine distinct population segments (DPS) of loggerhead sea turtles under the ESA (*Federal Register*, 2011b). Loggerheads found in the GOM are part of the Northwest Atlantic Ocean DPS. On March 25, 2013, the FWS published a proposed rule for the "Designation of Critical Habitat for the Northwest Atlantic Ocean Distinct Population Segment of the Loggerhead Sea Turtle (*Caretta caretta*)" (*Federal Register*, 2013c). On July 18, 2013, the NMFS published a proposed rule for the "Endangered and Threatened Species: Designation of Critical Habitat for the Northwest Atlantic Ocean Loggerhead Sea Turtle Distinct Population Segment (DPS) and Determination Regarding Critical Habitat for the North Pacific Ocean Loggerhead DPS" (*Federal Register*, 2013d).

To date for 2013, a notable increase in sea turtle strandings has occurred in the northern GOM as compared with 2012 stranding data. While turtle strandings in this region typically increase in the spring, the recent increase is a cause for concern. The Sea Turtle Stranding and Salvage Network is monitoring and investigating this increase. The network encompasses the coastal areas of the 18 states from Maine through Texas. There are many possible reasons for the increase in strandings in the northern GOM, both natural and human caused (USDOC, NMFS, 2013c). These sea turtle species include loggerhead, green, Kemp's ridley, leatherback, hawksbill, and unidentified species. As of August 25, 2013, NMFS has identified 44 strandings in Alabama, 198 strandings in Louisiana, and 196 strandings in Mississippi.

Debris ingestion, particularly plastic debris, is an ongoing threat to marine turtles. A recent literature and data synthesis by Schuyler et al. (2013) found that smaller individuals in the oceanic life stage are more likely to ingest debris than are individuals foraging in coastal areas; likewise, species that feed primarily on plants or gelatinous zooplankton ("jellyfish") are more likely to ingest debris than carnivorous species. In particular, oceanic green and leatherback turtles are at a higher risk for ingestion of pelagic floating plastics than benthic feeding carnivorous turtles. Increases in debris ingestion for leatherbacks in particular show an increasing trend until 1985, at which point the probabilities with ingestion leveled, suggesting that debris distribution may have stabilized and that the environment has reached a saturation point in which debris no longer reaches new areas but ends up in the same locations (Schuyler et al., 2013).

As of the conclusion of nesting season on August 31, 2013, 79 nests had been counted along the Alabama Gulf Coast (Share the Beach, 2013). In 2012, a total of 149 nests were counted along the Alabama Gulf Coast (Share the Beach, 2013). In 2011 and 2010, Alabama reported 84 and 41 sea turtle nests, respectively (Share the Beach, 2013). In Florida, the Northern Gulf of Mexico nesting loggerhead population declined by almost half between 1994 and 2010 (Lamont et al., 2012). Nesting surveys are not conducted in Mississippi or Louisiana due to logistical and funding limitations, although intermittent observations indicate that some nesting does occur (USDOI, FWS, 2013).

Postnesting Kemp's ridley female sea turtles appear to have foraging hotspots in the northern Gulf of Mexico, particularly in waters off Louisiana (Shaver et al., 2013). Loggerheads have been observed using both neritic habitats and oceanic habitats to forage based on size; smaller sea turtles use oceanic habitats and larger sea turtles remain nearshore in coastal areas to forage following nesting (Eder et al., 2012). Nesting activities by the northern Gulf of Mexico subpopulation suggest that site fidelity is significantly less than originally estimated, with several individuals using geographically separate beaches in the same nesting season. Additionally, some loggerheads use large ranges during inter-nesting periods in relatively shallow water not necessarily adjacent to nesting beaches; these long distance movements overlap areas of trawling and OCS oil and gas activities. In particular, loggerheads use neritic habitats off of Florida and Alabama as movement corridors and inter-nesting sites (Hart et al., 2013). More analyses and an understanding of sea turtle foraging behavior and site selection in the northern GOM is needed.

Recent work on PAH's (e.g., compounds found in crude oil, through combustion of fossil fuels, and urban runoff) suggests that PAH's may not be bioaccumulated throughout their lifetime and likely are related to recent exposure to waters or food sources contaminated by PAH's. High levels of PAH contaminants in smaller turtles may be related to their foraging strategies and suggest that, like other higher trophic organisms, sea turtles are able to metabolize PAH contaminants. Fluoranthene, in particular, was found at higher levels in sea turtles stranded following crude oil ingestion (Camacho et al., 2012). Increased levels of total proteins, albumin, globulins, and creatinine correlated with persistent organic pollutants and PAH's suggest that kidney function as well as other health parameters in sea turtles could be affected by exposure to these pollutants (Camacho et al., 2013).

Unavailable information on the effects to sea turtles from the *Deepwater Horizon* explosion, oil spill, and response (and thus changes to the sea turtle baseline in the affected environment), makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to sea turtles. Relevant data on the status of sea turtle populations after the *Deepwater Horizon* explosion, oil spill, and response and increased sea turtle GOM strandings may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis based upon accepted scientific methods and approaches. Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this Supplemental EIS (including the No Action and Action alternatives) for the two main reasons listed below:

(1) The CPA is an active oil and gas region with ongoing (or the potential for) exploration, drilling, and production activities. In addition, non-OCS oil- and gas-related activities will continue to occur in the CPA irrespective of a CPA proposed action (i.e., fishing, military activities, scientific research, and shoreline development). The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this Supplemental EIS. Impacts on sea turtles from either smaller accidental events or low-probability catastrophic events will remain the same.

(2) All wide-ranging populations of sea turtles that may occur in the CPA and within areas affected by the spill are unlikely to have experienced population-level effects from the *Deepwater Horizon* explosion, oil spill, and response given their wide-ranging distribution and behaviors.

Nevertheless, there are existing leases in the CPA with either ongoing or the potential for exploration, drilling, and production activities. In addition, non-OCS oil- and gas-related activities discussed above will continue to occur in the CPA irrespective of a CPA proposed action (i.e., fishing, military activities, and scientific research). The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or Action alternative is chosen under this Supplemental EIS.

4.1.1.14. Diamondback Terrapins

BOEM has reexamined the analysis for diamondback terrapins presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for two species listed as vulnerable, the Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) and the Texas diamondback terrapin (*Malaclemys terrapin littoralis*), presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The national and subnational conservation status ranks of Texas and Mississippi diamondback terrapins as vulnerable, at moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.14 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.14 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is below. New information that has become available since those documents were published is presented below.

A detailed description of both the Mississippi and the Texas diamondback terrapins can be found in Chapter 4.2.1.14.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.14 of the WPA 233/CPA 231 Supplemental EIS.

Impacts of Routine and Accidental Events

The following routine activities associated with proposed CPA Lease Sales 235, 241, and 247 would potentially affect diamondback terrapins: beach trash and debris generated by service vessels and OCS facilities; efforts undertaken for the removal of marine debris or for beach restoration; and vessel traffic (boat propeller strikes or groundings) with associated habitat (coastal marsh) erosion. A detailed impact analysis of the routine impacts of proposed CPA Lease Sales 235, 241, and 247 on diamondback terrapins can be found in Chapter 4.2.1.14.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.14 of the WPA 233/CPA 231 Supplemental EIS.

Adverse impacts due to routine activities resulting from the CPA proposed action are possible but unlikely. Because of the greatly improved handling of waste and trash by industry and because of the annual awareness training required by the marine debris mitigations, the plastics in the ocean are decreasing and the devastating effects on offshore and coastal marine life are minimizing. The routine activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any terrapin species or population in the GOM. Most routine, OCS oil- and gas-related activities are expected to have sublethal effects, such as behavioral effects, that are not expected to rise to the level of population significance.

Impact-producing factors associated with accidental events that may be associated with a CPA proposed action that could affect diamondback terrapins include offshore and coastal oil spills and spill-response activities. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sale 235 on diamondback terrapins can be found in Chapter 4.2.1.14.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.14 of the WPA 233/CPA 231 Supplemental EIS.

Impacts on Mississippi and Texas diamondback terrapins from smaller accidental events are likely to affect individual diamondback terrapins in the spill area, but they are unlikely to rise to the level of population effects (or a level of significance) given the probable size and scope of such spills. Further, the potential remains for smaller accidental spills to occur in the CPA proposed action area, regardless of any alternative selected under this Supplemental EIS, given that it is an active oil and gas region with either ongoing or the potential for exploration, drilling, and production activities.

The analyses in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS conclude that there is a low probability for catastrophic spills. **Appendix B** of this Supplemental EIS also concludes that there is a potential for a low-probability catastrophic event, though not reasonably foreseeable and not part of a CPA proposed action, to result in significant, population-level effects on affected diamondback terrapin species. BOEM continues to concur with the conclusions from these analyses.

Malaclemys terrapin are federally listed as a species of concern. “Species of concern” is an informal term that refers to those species that might be in need of concentrated conservation actions. Such conservation actions vary depending on the health of the populations and degree and types of threats. At one extreme, there may only need to be periodic monitoring of populations and threats to the species and its habitat. At the other extreme, a species may need to be listed as a federally threatened or endangered species under the ESA. Species of concern receive no legal protection above those already afforded the species under other laws, and the use of the term does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species. At the present time, the diamondback terrapin is neither a listed species nor a candidate for listing under the ESA.

Summary and Conclusion

The effects of a CPA proposed action, when viewed in light of the effects associated with other past, present, and reasonably foreseeable future activities may result in greater impacts to diamondback terrapins than before the *Deepwater Horizon* explosion, oil spill, and response; however, the magnitude of those effects cannot yet be determined. Nonetheless, to mitigate potential impacts from OCS oil- and gas-related activities, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTL's, to minimize these potential interactions and impacts. The operator's reaffirmed compliance with NTL 2012-BSEE-G01 ("Marine Trash and Debris Awareness and Elimination"), as well as the limited scope, timing, and geographic location of a CPA proposed action, would result in negligible effects from the proposed drilling activities on diamondback terrapins.

A complete understanding of the missing information is not essential to establish a reasoned choice among alternatives for this Supplemental EIS (including the No Action and Action alternatives). The potential for diamondback terrapins to be affected from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects will remain regardless of whether or not the No Action an Action alternative is chosen under this Supplemental EIS. The rate of current and historic loss of terrapin habitat in Louisiana, for example, far exceeds the potential impacts to terrapin habitat from the *Deepwater Horizon* explosion, oil spill, and response.

BOEM has reexamined the analysis for diamondback terrapins presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for diamondback terrapins presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because of the available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The major impact-producing factors that may affect the Texas diamondback terrapin (*Malaclemys terrapin littoralis*) and the Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) include oil spills and spill-response activities, alteration and reduction of habitat, and consumption of trash and debris.

OCS Oil- and Gas-Related Activities

The incremental contribution of a CPA proposed action to cumulative impacts on both the Texas and the Mississippi diamondback terrapins would be expected to be minimal. The major OCS oil- and gas-related, impact-producing factors that may affect the diamondback terrapin include (1) habitat destruction, (2) vessel traffic and road mortality, (3) exposure or intake of OCS oil- and gas-related contaminates or debris, and (4) oil spills and spill response.

Spending most of their lives within their limited home ranges at the aquatic-terrestrial boundary in estuaries, terrapins are susceptible to OCS oil- and gas-related habitat destruction (i.e., infrastructure construction, direct oil contact and associated cleanup efforts). Habitat loss has the potential to increase terrapin vulnerability to predation and increase competition. Pipelines from offshore oil and gas and other shoreline crossings have contributed to marsh erosion. However, a CPA proposed action would include only limited shoreline crossings and modern regulations requiring mitigation of wetland impacts. For additional effects of OCS oil- and gas-related habitat loss in beaches and dunes and in wetlands, refer to Chapters 4.2.1.3 and 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Refer to Chapter 4.2.1.23.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS for infrastructure-related habitat loss.

Vessel traffic and road mortality has the potential to affect diamondback terrapin populations. Terrapin populations are susceptible to propeller strikes by vessels traveling through wetland or beach habitat, and injury from strikes can cause mortality (Roosenburg, 1991). There have been no documented terrapin collisions with drilling and service vessels in the GOM. However, recreational vessel strikes in shallower waters of estuarine environments, where terrapins are most often found, is documented and suggests that there may be impacts associated with vessel traffic from OCS oil- and gas-related activities that require movement through estuarine habitat (Lester et al., 2012; Cecala et al., 2008). Vehicular traffic servicing ports or service bases located adjacent to terrapin habitat can lead to terrapin mortality, specifically during nesting season when gravid females emerge to lay their eggs (Szerlag and McRobert, 2006).

Behavioral effects and nonfatal exposure to or intake of OCS oil- and gas-related contaminants or discarded debris may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. 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 wildlife. The incidental ingestion of marine debris and entanglement could adversely affect terrapins. This Agency has established the guidance provided in NTL 2012-BSEE-G01, "Marine Trash and Debris Awareness and Elimination," which appreciably reduces the likelihood of terrapin encountering marine debris from a CPA proposed action. A CPA proposed action is expected to contribute negligible marine debris or disruption to terrapin habitat. Unless properly regulated, removing marine debris may temporarily disturb terrapins or trample nesting sites. Due to the extended distance from shore, most activities associated with the OCS Program are not expected to impact terrapins or their habitat.

Most spills related to a CPA proposed action, as well as oil spills stemming from tankering and prior and future lease sales, are not expected to contact terrapins or their habitats. Even after the oil is no longer visible, terrapins may still be exposed while they forage in the salt marshes lining the edges of estuaries where oil may have accumulated under the sediments and within the food chain (Burger, 1994; Roosenburg et al., 1999; Holliday et al., 2008). Oil spills that affect beaches and dunes could potentially reduce terrapin nest size and lead to reduced hatchability (Wood and Hales, 2001). Nests can also be disturbed or destroyed by cleanup efforts. In addition, terrapins rarely move from one tidal creek to another (Gibbons et. al, 2001). Even if an oil spill is contained to one area, localized extirpation may occur in a subpopulation; however, total population-level effects would not be expected. Refer to **Chapters 4.1.1.3 and 4.1.1.4** of this Supplemental EIS and Chapters 4.2.1.3 and 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS for additional effects OCS oil- and gas-related activity to habitat loss in beaches and dunes and in wetlands.

Data collected by the Operational Science Advisory Team indicate that the *Deepwater Horizon* explosion, oil spill, and response may have impacted the beach and brackish habitats associated with terrapin communities (OSAT, 2010). For those terrapin populations that may not have been impacted by the *Deepwater Horizon* explosion, oil spill, and response, it is unlikely that a future accidental event related to the CPA proposed action would result in significant impacts due to distance of most of the terrapin habitat from offshore OCS oil- and gas-related activities. As discussed in **Appendix B**, a low-probability catastrophic event could have population-level effects on diamondback terrapins. The best available information does not provide a complete understanding of the effects of the spilled oil and active response/cleanup activities related to the *Deepwater Horizon* explosion, oil spill, and response on the potentially affected terrapin environment.

Unavailable information on the effects to diamondback terrapins from the *Deepwater Horizon* explosion, oil spill, and response (and thus changes to the diamondback terrapin baseline in the affected environment) makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to diamondback terrapins. Relevant data on the status of diamondback terrapin populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches.

Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this Supplemental EIS (including the No Action and Action alternatives). The CPA is an active oil and gas region with ongoing (or the potential for) exploration, drilling and production activities. The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this Supplemental EIS. Impacts on diamondback terrapins from either smaller accidental events or low-probability catastrophic events will remain the same.

Non-OCS Oil- and Gas-Related Activities

Activities posing the greatest potential harm to terrapins are non-OCS oil- and gas-related factors, including (1) habitat destruction, (2) overharvesting and crab pot fishing, (3) vessel traffic and road mortality, (4) nest depredation, (5) State oil- and gas-related activity, and (6) natural processes.

Terrapin populations are susceptible to non-OCS oil- and gas-related habitat destruction (i.e., urban development, subsidence/sea-level rise, coastal land uses, coastal restoration program, and maintenance dredging), and road construction. Wave action from non-OCS oil- and gas-related vessel traffic can cause the erosion of important hibernating or nesting habitat. The development of waterfront property continues to reduce shoreline habitats available as habitat to terrapins. In addition, the use of stabilization fences on dunes near developed areas can impact the accessibility of nesting sites. For additional effects of non-OCS oil- and gas-related habitat loss in beaches and dunes and in wetlands, refer to **Chapters 4.1.1.3 and 4.1.1.4** of this Supplemental EIS and Chapters 4.2.1.3 and 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

Historically, the terrapin population suffered an initial decline due to overharvesting in the 1800's (Hogan, 2003). As the development of shoreline areas increased, there has been an increase in recreational and commercial crab fisheries. Terrapins are known to become entrapped in crab pots, especially young females and males. Long-term crab pot use has been suggested to influence the demographics of terrapin populations (Dorcas et al., 2007). While terrapin excluder devices have been developed, not all states require their use. Roosenburg et al. (1997) estimated that up to 78 percent of a terrapin subpopulation can die annually as a result of crab pot fishing.

Vessel traffic and road mortality has the potential to affect diamondback terrapin populations. Terrapin populations are susceptible to propeller strikes by vessels traveling through wetland or beach habitat, and injury from strikes can cause mortality (Roosenburg, 1991). Recent studies on behavioral responses of diamondback terrapin to recreational boat sounds suggest that terrapins are sensitive to boat frequencies but do not appear to respond behaviorally to the anthropogenic boat sounds (Lester et al., 2012). This failure to respond to boat sounds may be limiting populations in areas with heightened boat traffic. Major shell injuries and limb loss, many of which are attributed to boat propeller impact, has been shown to significantly reduce survivorship and reproductive output (Cecala et al., 2008).

Non-OCS oil- and gas-related traffic on roadways (e.g., to/from recreation or tourism areas) adjacent to terrapin habitat can lead to terrapin mortality, specifically during nesting season when gravid females emerge to lay their eggs (Szerlag and McRobert, 2006). Studies suggest that terrapin are attracted to the roadside because it meets the requirements for suitable nesting habitat (Szerlag and McRobert, 2006).

Characteristics of terrapin life history render this species especially vulnerable. These characteristics include low reproductive rates, low survivorship, limited population movements, and nest site fidelity year after year. In addition, non-OCS development can introduce predators to terrapin habitat by increasing the accessibility of the site (via road construction or other anthropogenic source). Raccoons alone can depredate more than 90 percent of nests of a single population (Feinberg and Burke, 2003).

State oil- and gas-related activities would affect terrapin populations in similar ways to OCS oil- and gas-related activities. Spills that occur as a result of State activity are generally closer to shore and are more likely to affect terrapin habitat. Non-OCS oil- and gas-related contamination and debris are expected to affect terrapins in a similar manner to OCS oil- and gas-related contamination and debris. For additional effects of non-OCS oil- and gas-related activities in beaches and dunes and in wetlands, refer to **Chapters 4.1.1.3 and 4.1.1.4** of this Supplemental EIS and Chapters 4.2.1.3 and 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

Natural processes (i.e., coastal erosion) and natural catastrophes (i.e., hurricanes and tropical storms), in combination, could potentially deplete some terrapin populations to unsustainable levels. Beach erosion from tropical storms and hurricanes could threaten their preferred nesting habitats.

Summary and Conclusion

Texas and Mississippi diamondback terrapins have experienced impacting pressures from habitat destruction, road construction, drowning in crab traps, and past overharvesting resulting in historical reductions in their habitat range and declines in populations. Inshore oil spills from non-OCS oil- and gas-related sources are potential threats to terrapins in their brackish coastal marshes. Pipelines from offshore oil and gas and other shoreline crossings have contributed to marsh erosion. However, a CPA proposed action includes only limited shoreline crossings, and modern regulations require mitigation of wetland impacts. Low-probability catastrophic offshore oil spills could affect the coastal marsh environment but such events are rare occurrences and may not reach the shore, even if they do occur. Therefore, the incremental contribution of a CPA proposed action is expected to be minimal, compared with non-OCS oil- and gas-related activities. The major impact-producing factors resulting from the cumulative activities associated with a CPA proposed action that may affect the diamondback terrapin include oil spills and spill-response activities, alteration and reduction of habitat, and consumption of trash and debris. Due to the extended distance from shore, impacts associated with activities occurring on the OCS are not expected to impact terrapins or their habitat. No substantial information was found at this time that would alter the overall conclusion that cumulative impacts on diamondback terrapins associated with a CPA proposed action would be expected to be minimal.

BOEM has considered this assessment and has reexamined the cumulative analysis for diamondback terrapins and the cited new information. Based on this evaluation, the conclusions in these analyses on effects to diamondback terrapins remain unchanged in regards to routine activities (no potential for significant adverse effects) and accidental spills (potential for significant adverse effects).

Overall, within the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting diamondback terrapin populations. Non-OCS oil- and gas-related activities will continue to occur in the CPA irrespective of a proposed CPA lease sale (i.e., crabbing, fishing, military activities, scientific research, and shoreline development). Therefore, in light of the above analysis of a CPA proposed action and its impacts, the incremental effect of a CPA proposed action on diamondback terrapins populations is not expected to be significant when compared with historic and current non-OCS oil- and gas-related activities, such as habitat loss, overharvesting, crabbing, and fishing.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources (NOAA's and FWS's websites, and the RestoreTheGulf.gov website), as well as recently published journal articles was conducted to determine the availability of recent information on diamondback terrapins. The search revealed little new information pertinent to this Supplemental EIS.

Non-OCS impacts from boat injuries are prevalent in terrapins and may be detrimental to populations but has had limited research conducted on its impacts. Recent studies on behavioral responses of diamondback terrapins to recreational boat sounds suggest that terrapins are sensitive to boat frequencies but do not appear to respond behaviorally to the anthropogenic boat sounds (Lester et al., 2012). This failure to respond to boat sounds may be limiting populations in high boating traffic areas. Major shell injuries and limb loss, many of which are attributed to boat impact, have been shown to significantly reduce survivorship and reproductive output (Cecala et al., 2008).

Diamondback terrapins within the CPA may have been impacted by the *Deepwater Horizon* explosion, oil spill, and response, based on the best available information and the CPA's distance from the *Macondo* well. The best available information on impacts to diamondback terrapins and their habitat does not yet provide a complete understanding of the effects of the oil spilled and active response/cleanup activities from the *Deepwater Horizon* explosion, oil spill, and response. As identified in the resource analyses in this Supplemental EIS, 2012-2017 WPA/CPA Multisale EIS, and WPA 233/CPA 231 Supplemental EIS, incomplete or unavailable information regarding diamondback terrapins in the CPA may be relevant to reasonably foreseeable significant adverse effects. As data continue to be gathered and impact assessments completed, a better characterization of the full scope of the impacts to the terrapin populations in the GOM from the *Deepwater Horizon* explosion, oil spill, and response will be available. Relevant data on the status of diamondback terrapin populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted scientific methods and approaches. BOEM has determined that the information is not essential to a reasoned choice among alternatives.

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

BOEM has reexamined the analysis for Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice (hereafter "beach mice") presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for beach mice presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sale 235, 241, and 247.

A detailed description of the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.15 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The major impact-producing factors associated with routine activities of a CPA proposed action that may affect beach mice include beach trash and debris, and efforts undertaken for the removal of marine debris or for beach restoration. A detailed impact analysis of the routine impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on beach mice can be found in Chapter 4.2.1.15.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.15 of the WPA 233/CPA 231 Supplemental EIS.

Impacts from the routine activities associated with a CPA proposed action on beach mice are possible but unlikely. Impacts may result from consumption of or entanglement in beach trash and debris. It is expected that debris from a CPA proposed action would account for a small portion of the total debris that would reach beach mice habitat; thus, the impacts from a CPA proposed action would be minimal. The BSEE prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR § 250.300; also refer to NTL 2012-BSEE-G01 "Marine Trash and Debris Awareness and Elimination"). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters. Unless all personnel are adequately trained, efforts undertaken for the removal of marine debris may temporarily scare away beach mice or destroy their food resources, such as sea oats. However, their burrows have a plugged escape tunnel that would become functional if the main entrance was trampled. Sea oats are a protected species at the State and local level throughout all beach mice habitat, theoretically reducing the potential for destruction (refer to City of Gulf Shores Ordinance No. 2012-1141, ADEM Administrative Code Regulations 335-8-2-.08, and Florida Statute Title XI 161.242).

The major impact-producing factors resulting from accidental events associated with a CPA proposed action that may affect beach mice include offshore and coastal oil spills, and spill-response activities. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on beach mice can be found in Chapter 4.2.1.15.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.15 of the WPA 233/CPA 231 Supplemental EIS.

The oiling of beach mice or beach mice critical habitat could result in local extinction. Oil-spill-response and cleanup activities could also have a substantial impact to the beach mice and their habitat if all cleanup personnel are not adequately trained. However, potential spills that could result from a CPA proposed action are not expected to wash onto or over the foredunes of beach mouse habitat (refer to **Appendix B** of this Supplemental EIS and Figure 3-11 of the 2012-2017 WPA/CPA Multisale EIS). Also, inshore facilities related to a CPA proposed action are unlikely to be located on beach mouse habitat.

Within the last 20-30 years, the combination of habitat loss due to beachfront development, the isolation of remaining beach mouse habitat areas and populations, and the destruction of remaining habitat by tropical storms and hurricanes has increased the threat of extinction of several subspecies of beach mice. Destruction of the remaining habitat, including critical habitat, due to a low-probability catastrophic spill and cleanup activities would increase the threat of extinction, but the potential for a catastrophic spill that would substantially affect beach mice habitat is low.

A review of the available information shows that impacts on beach mice from accidental impacts associated with a CPA proposed action would be minimal.

Summary and Conclusion

New information does not indicate a change in the conclusions identified in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. An impact from the routine activities associated with a CPA proposed action on Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. Impacts on beach mice from accidental impacts that may be associated with a CPA proposed action would also be minimal. The expected incremental contribution of a CPA proposed action to the cumulative impacts remains small.

No new significant information was discovered that would alter the impact conclusion for the beach mice presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in th WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

This cumulative analysis considers the possible cumulative effects of all activities in the CPA on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice, which are protected species under the ESA, and the Santa Rosa beach mouse (located in the same area but not listed under the ESA). Also included in this analysis are the federally threatened southeastern beach mouse and the federally endangered Anastasia Island beach mouse on the east coast of Florida, which are discussed because they could be exposed to an oil spill in the CPA if it was entrained in the Loop Current and was carried to their locations.

The major impact-producing factors that affect beach mice include OCS oil- and gas-related impacting factors such as oil spills (offshore and coastal) and associated cleanup operations, consumption of and entanglement in beach trash and debris, and non-OCS oil- and gas-related impacting factors such as beach development and alteration and reduction of habitat, predation (especially from domestic cats), competition, and natural catastrophes (i.e., hurricanes and tropical storms).

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas-related beach trash and debris and associated removal efforts may impact beach mice. The beach mice may consume the trash and debris, and they may become entangled in the debris. If a burrow is trampled by foot traffic of insufficiently trained debris cleanup personnel, it is likely beach mice could dig themselves out. However, they would be subject to additional energetic expenditure associated with rebuilding the burrow.

Most proposed action-related spills, as well as oil spills stemming from prior and future lease sales, are not expected to contact beach mice or their habitats, and no major impacts from associated cleanup operations are expected. If personnel are properly trained (on short notice if under emergency conditions) and supervised, these impacts could be reduced. Cumulative impacts could potentially deplete some beach mice populations to unsustainable levels. However, the expected incremental contribution of a CPA proposed action to the cumulative impacts is negligible.

Due to the extended distance of most OCS activities from shore, the incremental impacts associated with a CPA proposed action are not expected to impact beach mice when compared with the cumulative effects of non-OCS oil- and gas-related factors nearer to shore.

Non-OCS Oil- and Gas-Related Impacts

Substantial habitat loss due to sea-level rise is not expected to seriously affect beach mice habitat. The eastern Gulf of Mexico (Alabama and Florida) is underlain by a stable carbonate platform (limestone) that is not subject to subsidence to any substantial degree, and so it is predominantly influenced by absolute sea-level rise. A tidal gauge at Pensacola, Florida, showed an average relative sea-level rise of 2.1 mm/year. Absolute long-term, sea-level rise is expected to result in landward movement of beach and dune habitat, but the total habitat area may not necessarily decline from this sea-level rise alone.

Non-OCS oil- and gas-related beach trash and debris and associated removal efforts may impact beach mice. The beach mice may consume trash and debris, and they may become entangled in the debris. If a burrow is trampled by foot traffic of insufficiently trained debris cleanup personnel, beach mice could dig themselves out. However, they would be subject to additional energetic expenditure associated with rebuilding the burrow.

Predation by domestic cats is a serious threat to many native rodent species. According to the most up-to-date reference on the subject (Cascades Raptor Center, 2013), the only two available sources of reliable data on outdoor cats and beach mouse populations are 20-32 years old and indicate that "…cats introduced by people living on the barrier islands of Florida's coast have depleted several unique species of mice and woodrats to near extinction." More generally, domestic cats are an invasive species and have impacts on wildlife that feral cats and natural predators do not. Cats in general have more impact on wildlife than do natural predators. Competition between the hispid cotton rat (*Sigmodon hispidus*) and Alabama beach mouse may increase after a hurricane if the beach mouse is forced into a smaller habitat area (interior dune refuges) by hurricane damage to foredune habitat (Falcy, 2011; Yuro, 2011). The effects of oil spills from State oil- and gas-related activity and import tankering are expected to be similar to those of OCS oil- and gas-related impacts, and they are not expected to contact beach mice or their habitats. If personnel are properly trained (on short notice if under emergency conditions) and supervised, these impacts could be reduced.

Population viability analysis (PVA) is a demographic modeling exercise to predict the likelihood a population will continue to persist over time given the influence of stochastic (i.e., unpredictable) events (Groom and Pascual, 1998). The PVA models have potential problems with usefulness to managers because they are untested and complex (Hanski, 1999). The objective of a PVA for beach mice is to determine how large and what configuration of habitat is necessary to reasonably assure that the species will survive to recover. In the first version of a PVA model of the Alabama beach mouse, many of the model parameters were uncertain and may have been inaccurate, resulting in uncertainty in the probability of Alabama beach mouse extinction (Traylor-Holzer et al., 2005). The model was revised after Hurricane Ivan (Traylor-Holzer, 2005) and then data collected after Hurricane Katrina were used in a second revision of the model (Reed and Traylor-Holzer, 2006). The most recent revised model projects a risk of extinction of 26.8 ± 1.0 percent over the next 100 years. Destruction of migration corridors between populations raises the risk to 41.2 ± 1.1 percent, but only 34.9 ± 1.1 percent with the translocation of mice. Total loss of private land as suitable habitat raises the risk further to 46.8 ± 1.1 percent, but only 40.8 ± 1.1 percent with the translocation of mice.

Falcy (2011) used modelling to show smooth recovery of Alabama beach mouse populations during the 4 years after Hurricane Ivan (2004) and Hurricane Katrina (2005). Further modelling (Falcy, 2011) showed that increasing the rate of population growth in a refuge, like interior dunes after a hurricane, would have a much larger effect on population persistence than increasing the rate of recovery of damaged habitat, like foredunes after a hurricane. Occupancy of frontal dunes by Santa Rosa beach mice dropped from 100 percent to 40 percent after Hurricane Ivan, but occupancy of interior (scrub) dunes at 75 percent did not change (Pries et al., 2009). Yuro (2011) studied Hurricanes Ivan and Katrina and showed that the Alabama beach mouse has the ability to survive hurricanes if they are not successive. Hurricanes cause increased fragmentation of habitat, which is correlated with increased distance (gap width) between fragments that must be crossed by beach mice at night if they are to move between habitat patches. Beach mice, which are nocturnal, may prefer to cross narrower gaps to avoid exposure to predators (Wilkinson et al., 2013). The frequency of gap crossing may decrease when visibility is good during the full moon when mice are more visible to predators, as compared with the frequency during the new moon (Wilkinson et al., 2013). Within the historic ranges of the four Gulf Coast beach mouse subspecies, between 1851 and 2006, 58 hurricanes have made landfall in northwest Florida and 21 hurricanes have made landfall in Alabama (McAdie et al., 2009; USDOC, NOAA, National Hurricane Center, 2012). This high historic and contemporary frequency of extreme disturbance has been a form of natural selection to which the beach mice were adapted until it was combined with anthropogenic habitat loss and fragmentation.

Summary and Conclusion

New information does not indicate a change in the conclusions identified in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/ CPA 231 Supplemental EIS. Cumulative activities have the 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, consumption of and entanglement in beach trash and debris, beach development, and natural catastrophes (hurricanes and tropical storms). Most spills related to a CPA proposed action and prior and future lease sales are not expected to contact beach mice or their habitats because the species lives above the mean high waterline where contact is less likely. Cumulative impacts could potentially deplete some beach mice populations to unsustainable levels, but non-OCS oil- and gas-related drivers are expected to have a greater impact than OCS activities. The expected incremental contribution of a CPA proposed action to the cumulative impacts is negligible.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search for new information available since the publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS identified several new publications, but none were pertinent to OCS oil- and gas-related activities and their effects. Searches were made using EBSCO, ScienceDirect, Google Advanced Scholar Search, and Google Advanced Book Search using the keywords "beach mouse," "dunes," and "*Peromyscus polionotus*." The Internet was searched for any new information, and a local FWS beach mouse expert was contacted (Frater, official communication, 2013). Updated information on hurricane frequencies that affected beach mice habitats was identified and incorporated into the cumulative impact analysis above.

BOEM acknowledges that there remains incomplete or unavailable information regarding beach mice, including information regarding the *Deepwater Horizon* explosion, oil spill, and cleanup and impacts from that spill to beach mice. Nevertheless, there is scientifically credible information regarding the likelihood that beach mice were minimally impacted by oil and related tarballs from the *Deepwater Horizon* explosion. Current studies are investigating the effects of *Deepwater Horizon* explosion, oil spill, and response activities on beach mice and their habitat (Frater, official communication, 2013). This research is being conducted through the NRDA process and may be years from completion. These data and conclusions are currently under litigation and are unavailable. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline contemplated in the NEPA analysis of this Supplemental EIS. In its place, BOEM has included what scientifically credible information is available and applied it using accepted scientific methodologies. Although information resulting from this study may be relevant to reasonably foreseeable adverse impacts on beach mice and their habitat, BOEM's subject-matter experts have determined that it is not essential to a reasoned choice among the alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. BOEM has conservatively considered the potential for impacts from cleanup activities.

4.1.1.16. Coastal and Marine Birds

BOEM has reexamined the analysis for coastal and marine birds presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for coastal and marine birds presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.16 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS and

WPA 233/CPA 231 Supplemental EIS. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The majority of the effects resulting from routine activities of a CPA proposed action (**Tables 3-2 through 3-4**) on threatened or endangered (Table 4-1 of the WPA 233/CPA 231 Supplemental EIS) and nonthreatened and nonendangered coastal and marine birds are expected to be sublethal, primarily disturbance-related effects (Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS). Major potential impact-producing factors resulting from routine activities for marine birds in the offshore environment include the following:

- habitat loss and fragmentation (Fahrig, 1997 and 1998);
- behavioral effects primarily due to disturbance from OCS helicopter and service-vessel traffic and associated noise (Habib et al., 2007; Bayne et al., 2008);
- mortality due to exposure and intake of OCS oil- and gas-related contaminants, e.g., drilling discharges and produced waters (Wiese et al., 2001; Fraser et al., 2006) and discarded debris (Robards et al., 1995; Pierce et al., 2004);
- sublethal, chronic effects from air emissions (Newman, 1979; Newman and Schreiber, 1988); and
- mortality and energetic costs associated with structure presence and associated light (Russell, 2005; Montevecchi, 2006).

A detailed impact analysis of the routine OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on coastal and marine birds can be found in Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS.

Overall, impacts to avian species from routine activities are expected to be adverse but not significant.

Impact-producing factors from accidents include oil spills, regardless of size and despite oil-spill cleanup activities, including the release of rehabilitated birds. A detailed impact analysis of the accidental impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, and 247 on coastal and marine birds can be found in Chapter 4.2.1.16.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS.

Oil-spill impacts on birds from a CPA proposed action are expected to be adverse but not significant, given the number and relatively small size of spills expected over the 40-year life of a CPA proposed action (Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS). Impacts of oil-spill cleanup from a CPA proposed action are also expected to be adverse, but not significant, but may be negligible depending on the scope and scale of efforts. Significant impacts to coastal and marine birds could result in the event of a low-probability catastrophic spill, depending on the timing, location, and size of the spill. For additional information on a low-probability catastrophic spill, refer to **Appendix B**.

Summary and Conclusion

BOEM has reexamined the analysis for coastal and marine birds presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information provided above. At the present time, there is no way to discern if the additional levels of annual (>200,000; 50 birds per platform [Russell, 2005] for about 4,000 platforms) or long-term mortality (over the life of newly installed platforms) for any of the affected trans-Gulf migrant species considered herein results in population-level impacts (Russell, 2005, Chapters 17 and 18). Given what we know about the life-history characteristics of many of these species (e.g., age at first reproduction, clutch size, and nest success), the potential for major population-level impacts seems relatively low (Arnold and Zink, 2011, page 2). Various Internet sources that may be pertinent to the CPA were examined to assess recent information regarding this resource. No new significant information was discovered that would alter the impact conclusion for these coastal and marine birds presented in the 2012-2017 WPA/CPA Multisale

EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

A detailed impact analysis of the coastal and marine birds for a CPA proposed action can be found in Chapters 4.2.1.16.1, 4.2.1.16.2, and 4.2.1.16.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS, all of which are hereby incorporated by reference. The following is an analysis of the cumulative impacts to coastal and marine birds. Additional information on impacts to birds and results from avian monitoring related to the *Deepwater Horizon* explosion, oil spill, and response can be found in Chapter 4.2.1.16.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS (Tables 4-8 and 4-12 through 4-15 of the 2012-2017 WPA/CPA Multisale EIS; refer also to USDOI, FWS, 2011a). The incremental contribution of a CPA proposed action to the cumulative impact is considered adverse but not significant.

A more detailed discussion of catastrophic OCS oil- and gas-related events can be found in **Appendix B**. Information regarding a CPA proposed action and the associated activity levels and oil-spill information can be found in **Tables 3-2 and 3-4** of this Supplemental EIS and in Tables 3-12, 3-18, and 3-21 of the 2012-2017 WPA/CPA Multisale EIS.

Background/Introduction

This cumulative analysis considers impact-producing factors that may adversely affect populations of threatened and endangered avian species, as well as nonthreatened and nonendangered species, related to OCS oil- and gas- and non-OCS oil- and gas-related activities. For simplicity sake, both listed and nonlisted avian species are considered together, although it is recognized that potential impacts from OCS oil- and gas-related activities may have relatively greater overall negative effects to listed species than nonthreatened and nonendangered species.

Several OCS oil- and gas-related impact-producing factors could potentially affect coastal and marine birds, including the following: air pollution; degradation of water quality; oil spills and any improperly directed spill response as a result of OCS activity; structure lights and structure lighting; aircraft and vessel traffic and noise; maintenance and use of navigation waterways; habitat loss from coastal facility and OCS support structure construction; new pipeline landfalls; and impacts from OCS oil- and gas-related trash and debris.

In addition to the factors listed above, there are several non-OCS oil- and gas-related impact-producing factors that could potentially impact coastal and marine birds. These factors include the following: air pollution; habitat loss, alteration, and fragmentation associated with commercial and residential construction and industrial growth; water pollution including State or tanker oil- and gas-related spills and any spill-response activities and pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; aircraft and vessel (including military) activities and noise; nonconsumptive and consumptive recreation; maintenance and use of navigation waterways; collisions with anthropogenic structures; predation; diseases; climate change and related impacts; impacts from storms and floods; fisheries interactions; and trash and debris.

OCS Oil- and Gas-Related Impacts

Air Pollutants

Air pollutants include the amount of sulfur dioxide and other regulated pollutants (**Chapter 4.1.1.1** of this Supplemental EIS, Chapter 4.2.1.1 and Table 4-1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.1 of the WPA 233/CPA 231 Supplemental EIS) expected to be released due to a CPA proposed action, as well as from prior and future OCS lease sales. These pollutants may adversely affect coastal and marine birds and their habitats (Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS). Pollutant emissions into the atmosphere from OCS oil- and gas-related activities under the cumulative analysis are expected to have minimal effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations, as regulated by USEPA (Wilson et al., 2010, Tables 8-1 and 8-2). Onshore impacts to air quality from emissions under the OCS oil- and gas-related cumulative analysis are expected to be within both PSD Class I and Class II allowable increments, as applied to the respective subareas. Emissions of pollutants into the atmosphere under the OCS oil- and gas-related cumulative analysis are projected to have minimal effects on onshore air quality because of the atmospheric regime, emission rates (Table 4-1 of the 2012-2017 WPA/CPA Multisale EIS), and the distance of these emissions from the coastline. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} under the OCS oil- and gas-related cumulative analysis are estimated to be less than PSD Class I and Class II allowable increments for the respective subareas as per both the steady-state and plume dispersion analyses, and they are assumed to be below concentrations that could harm coastal and marine birds (**Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS; also refer to Newman, 1979; Newman and Schreiber, 1988).

For coastal and marine birds, direct impacts (on individuals) and indirect impacts (on habitat or food supply) due to air quality under the OCS oil- and gas-related cumulative analysis may include chronic, sublethal effects leading to overall reduced recruitment. The incremental contributions of offshore emissions are below or within those allowed by USEPA, but it is uncertain to what extent air pollutants from OCS oil- and gas-related activities could adversely impact birds in the GOM region. Nevertheless, these impacts would not be expected to rise to population-level impacts across the GOM.

Degradation of Water Quality

Water quality (**Chapter 4.1.1.2** of this Supplemental EIS, Chapter 4.2.1.2 and Tables 3-8, 3-9, and 3-23 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.2 of the WPA 233/CPA 231 Supplemental EIS) of coastal environments will be affected by bilge water from service vessels and point- and nonpoint-source discharges from supporting infrastructure. Water quality in marine waters will be impacted by the discharges from drilling, production, and platform removal operations. Degradation of water quality resulting from factors related to a CPA proposed action, plus those related to prior and future OCS lease sales, is expected to adversely impact coastal and marine birds (**Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS).

The overall coastal condition of the Gulf Coast estuaries was evaluated from 2003 to 2006 by USEPA and was rated 2.4 on a scale of 1 (poor) to 5 (good). This represented an improvement from the early 1990's (USEPA, 2012a). The incremental addition related to a CPA proposed action will contribute to further degradation of water quality, but this remains a small addition when compared with all other natural and anthropogenic sources.

Produced water is an important OCS oil- and gas-related activity factor affecting birds. Pollutants discharged into navigable waters of the U.S. are regulated by USEPA under the Clean Water Act of 1972 and subsequent provisions (33 U.S.C. § 1251 *et seq.*; **Chapter 3.1.1.4** of this Supplemental EIS). Specifically, an NPDES permit must be obtained from USEPA under Sections 301(h) and 403 (*Federal Register*, 1980) of the Clean Water Act. From 2000 to 2012, OCS oil- and gas-related activities generated between 489.0 and 648.2 MMbbl of produced waters (**Chapter 3.1.1.4 and Table 3-5** of this Supplemental EIS and Chapter 3.1.1.4 of the 2012-2017 WPA/CPA Multisale EIS). Produced water, including its constituent pollutants, is the largest waste stream associated with oil and gas production (Veil et al., 2004; Welch and Rychel, 2004; Clark and Veil, 2009). The volume of produced water is not constant over time and increases over the life of an individual well (Veil et al., 2004). Produced water is comprised of a number of different substances, including trace heavy metals, radionuclides, sulfates, treatment chemicals, produced solids, and hydrocarbons (Veil et al., 2004). Impacts to birds from pollutants remaining in produced water may be from ingestion or contact (direct) or from the changes in the abundance, distribution, or composition of preferred foods (indirect). O'Hara and Morandin (2010) documented measurable oil transfer to feathers and impacts to feather microstructure at sheen thickness as low as 0.1-0.3 micrometers. Even a light coating of hydrocarbons and other substances found in produced water can negatively affect feather microstructure, potentially compromising its buoyancy, insulation (i.e., thermoregulatory function and capacity), and flight characteristics (Stephenson, 1997; O'Hara and Morandin, 2010). Analyses herein are based, in part, on the following assumptions: (1) the regulatory limits established by USEPA eliminate or significantly reduce the potential for negative effects to most birds; and (2) produced water and its constituent pollutants will be diluted simply as a function of the dilution potential of the ocean, minimizing potential harm to birds. BOEM relies on self-reporting and self-monitoring by individual companies relative to produced waters. There is uncertainty as to the potential effects of this routine activity on seabirds that overlap spatially and temporally with produced-water discharge events in the CPA (Stephenson, 1997; Wiese et al., 2001; Burke et al., 2012).

Platform and Pipeline Oil Spills and Any Improperly Directed Spill-Response Activities

The potential effects associated with accidental oil spills are only briefly discussed here. A more detailed discussion of oil-spill effects/impacts to avian resources (birds) is provided in **Chapter 4.1.1.18** of this Supplemental EIS, Chapter 4.2.1.18.3 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.18 of the WPA 233/CPA 231 Supplemental EIS. Oil spills have the greatest potential to impact coastal and marine birds (Tables 4-8, 4-12, and 4-13 of the 2012-2017 WPA/CPA Multisale EIS). Mortality is associated with oil spills or chronic oil pollution (Wiese and Robertson, 2004; Wilhelm et al., 2007; Camphuysen, 2010). It is well understood that the anthropogenic input of accidental spills varies temporally and, in the GOM, the years in which major hurricanes occurred resulted in a higher frequency of spills as well as a greater annual volume (USDOI, MMS, 2009b; Anderson et al., 2012). Oil spills and chronic oil pollution both result in the direct mortality of seabirds worldwide and result in major avian losses regionally and locally (Newton, 1998, pages 429-431; also refer to Table 4-15 of the 2012-2017 WPA/CPA Multisale EIS). Use of waterbird, marshbird, shorebird, and seabird feeding areas at the sea surface and at the intertidal wetland zone, where spilled oil may accumulate, makes many avian species extremely vulnerable to spilled oil (Tables 3-11, 3-12, 3-17, 3-18, and 3-21 of the 2012-2017 WPA/CPA Multisale EIS). Depending on the timing and location of the spill, even small spills can result in major avian mortality events (refer to Dunnet, 1982; Piatt et al., 1990; Castège et al., 2007). One or many episodes of exposure to small amounts of oil may result in sublethal impacts on birds, with the potential to impact preferred food resources through changes in distribution and abundance (i.e., availability) of preferred foods (Golet et al., 2002). Mortality from oil spills is often related to numerous symptoms of toxicity. Data on spill size, frequency, and source are given in Tables 3-11, 3-12, and 3-21 of the 2012-2017 WPA/CPA Multisale EIS.

The extensive oil and gas industry operating in the Gulf area may have caused low-level, chronic, petroleum contamination of coastal waters (Tables 3-11, 3-17, 3-18, and 3-23 of the 2012-2017 WPA/CPA Multisale EIS; Holdway, 2002; Jernelöv, 2010). Outside of a low-probability catastrophic event, petroleum spills or releases that result from a CPA proposed action or OCS energy program would be expected to be small, particularly when compared with naturally occurring seeps in the GOM (Tables 3-8 and 3-9 of the 2012-2017 WPA/CPA Multisale EIS). Nevertheless, lethal effects are expected primarily from uncontained, inshore oil spills and associated spill-response activities in wetlands and other biologically sensitive coastal habitats (National Audubon Society, Inc., 2010; USDOI, FWS, 2010). Recruitment of birds and a population's recovery from a major mortality event may take many years, depending upon the species and its life-history strategy (Table 4-13 of the 2012-2017 WPA/CPA Multisale EIS; Figures 4-18 and 4-19 of the 2012-2017 WPA/CPA Multisale EIS). Long-term effects, in some cases, may persist for ≥20 years (e.g., Peterson et al., 2003). Though the *Deepwater Horizon* explosion, oil spill, and response only resulted in the collection of >7,000 birds (Figure 4-17 of the 2012-2017 WPA/CPA Multisale EIS), the total model-estimated mortality associated with this spill has not yet been determined. The effects on impacted populations are presently poorly understood, though species-specific life-history traits will largely determine a given species response to the spill (Table 4-13 of the 2012-2017 WPA/CPA Multisale EIS). Refer to Anderson et al. (2012) for additional information specific to OCS oil- and gas-related oil spills. A more detailed discussion of catastrophic OCS oil- and gas-related events can be found in **Appendix B**.

Structure Lights and Structure Presence

Migratory land birds may be impacted by OCS oil- and gas-related attraction to platforms, nocturnal circulation (night flights) around platforms, and collision with platforms. Every spring, about 300 million migratory landbirds, mostly neotropical passerines, cross the Gulf of Mexico from wintering grounds in Latin America to breeding grounds north of the Gulf of Mexico (Russell, 2005). Migration peaks from mid-March through the end of May. The reverse migration is repeated again in the fall with a peak around mid-August through early November (Russell, 2005). Migrants sometimes arrive at platforms shortly after night fall or later and proceed to circle those platforms (referred to as a nocturnal circulation event) for variable periods ranging from minutes to hours (Russell, 2005). Nocturnal circulation events around platforms may create lethal effects from collisions with platforms (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS), acute sublethal stress from energy loss, and increased predation risks. At present, it is unknown if birds participating in nocturnal circulation events actually have sufficient energy reserves post-event to successfully complete their migration. It is estimated that collisions with platforms in the GOM leads to an annual mortality of 200,000-321,000 birds (Table 4-7, footnote 5 of the 2012-2017 WPA/CPA Multisale EIS). Conservatively, a CPA proposed action may increase this level of mortality by 1,750-3,350 birds/year. Over the life of the entire platform archipelago, a range of 7.6-12.2 million birds may be killed, primarily due to collisions (Table 4-7, footnote 5 of the 2012-2017 WPA/CPA Multisale EIS). Mitigating measures such as changing the lighting type, light color, and/or light intensity may decrease the attraction to platforms and the associated collision risk to migratory birds (Wiese et al., 2001; Montevecchi, 2006) and may potentially reduce the frequency and duration of nocturnal circulation events associated with well-lit (standard white lights) platforms.

It is uncertain if this level of mortality has population-level effects for any of the species involved, but it appears unlikely because of what is known of their life-history strategies (e.g., age at first reproduction, clutch size, nest success, etc.) (Arnold and Zink, 2011, page 2).

Though presently there are no mitigations in place to address circulation events and attraction of birds to platforms and the associated collision risk, BOEM has recently proposed a study to determine if changes to present lighting systems on platforms might reduce associated avian mortality. The attraction of birds by visible light varies with the wavelength of the light and may not happen (Poot et al., 2008).

Aircraft and Vessel Traffic and Noise from Helicopters and Service Vessels

Helicopter and service-vessel traffic related to OCS oil- and gas-related activities would likely disturb the behavior of birds (at least temporarily). Effects tend to manifest themselves through behavioral changes such as decreased foraging time, reduced foraging efficiency, and increased energy expenditure due to flight associated with a disturbance. The Federal Aviation Administration (Advisory Circular 91-36C) and corporate helicopter policy states that helicopters must maintain a minimum altitude of 700 ft (213 m) while in transit offshore and 500 ft (152 m) while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft (305 m) over unpopulated areas or across coastlines and 2,000 ft (610 m) over populated areas and biologically sensitive areas such as wildlife refuges and national parks. The net effect of OCS oil- and gas-related flights on coastal and marine birds is expected to result in temporary, often sporadic disturbances, which may result in the displacement of localized flocks. Service vessels are expected to use selected nearshore and coastal (inland) navigation waterways and are further expected to adhere to guidelines established by USCG for reduced vessel speeds within inland areas. Routine presence and low speeds of service vessels within these waterways is expected to reduce the disturbance effects from service vessels on nearshore and inland populations of coastal and marine birds. It is estimated that the effects of both OCS oil- and gas-related and non-OCS oil- and gas-related vessel traffic on birds within coastal areas are not substantial.

For a more detailed discussion of disturbance-related impacts, refer to **Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS.

Maintenance and Use of Navigation Waterways

Construction of navigation canals for OCS oil- and gas- related development have generated substantial adverse impacts to coastal wetlands (Ko and Day, 2004; Morton et al., 2006; Day et al., 2007; Figures 3-5 and 3-7 of the 2012-2017 WPA/CPA Multisale EIS). Initial impacts are locally substantial but largely limited to where canals and channels pass through wetlands. Periodic maintenance dredging is necessary and expected in existing OCS oil- and gas-related navigation channels through barrier passes and associated bars (Johnston et al., 2009). Much of the impacts from OCS oil- and gas-related oil and gas development on coastal wetlands has already occurred. From 1998 through 2004, wetland losses from all causes for all coastal wetland types were estimated at 442,200 ac (178,952 ha) (Stedman and Dahl, 2008; Engle, 2011, Table 1). Current channels should not be altered dramatically as a result of a

CPA proposed action. In addition, no new channels will be required by a CPA proposed action (refer to **Chapters 3.3.4.3 and 4.1.1.4** of this Supplemental EIS for more information on navigation canals).

Habitat Loss, Alteration, and Fragmentation Resulting from OCS Oil- and Gas-Related Coastal Facility Construction and Development

Under the cumulative activities scenario, factors contributing to coastal landloss or modification include the construction of 0-1 gas processing plants for a CPA proposed action, as well as other associated roads, pads, and facilities (for existing installations and transportation bases and various types of infrastructure, refer to Tables 3-13, 3-15, and 3-16 and Figures 3-5, 3-6, and 3-7 of the 2012-2017 WPA/CPA Multisale EIS). The realized footprints of this construction tend to be relatively small based on an acreage basis. The OCS activities that include oil and gas processing terminals and associated roads and infrastructure result in the destruction or fragmentation of otherwise suitable avian habitats and can force affected individuals to disperse to other nonimpacted habitats, assuming it is available and of similar or greater quality. In the offshore environment, disturbance-related effects can result in temporary functional loss of habitat, as individuals are forced to disperse from impacted sites. Many of the overwintering shorebird species remain within relatively well-defined, winter-use areas throughout the season, and some species exhibit among-year wintering site fidelity, at least when not disturbed by humans. These species are particularly vulnerable to localized impacts, resulting in habitat loss or fragmentation, unless they disperse to other favorable habitats when disturbed. Cumulative activities related to a CPA proposed action will likely contribute to further loss, alteration, and fragmentation of avian habitat although certainly at a much smaller spatial scale than non-OCS residential, commercial, and industrial construction and development activities.

Pipeline Landfalls

Under the cumulative activities scenario, factors contributing to coastal landloss or modification include the construction of 0-1 pipeline landfalls for a CPA proposed action. From 1996 through 2009, there were 12 OCS oil- and gas-related pipeline landfalls in Louisiana and Texas (Table 3-16 of the 2012-2017 WPA/CPA Multisale EIS). Refer to Figure 3-5 of the 2012-2017 WPA/CPA Multisale EIS for transitioning pipelines in Louisiana and Texas. Refer to **Chapters 4.1.1.4** of this Supplemental EIS for more details regarding the impacts to wetlands; also refer to reviews by Gosselink et al. (1998). Dahl (2006) estimated an annual loss rate of 5,540 ac (2,242 ha) for the intertidal estuarine and marine wetland class, mostly in Louisiana, from all impacting factors.

Trash and Debris

Coastal and marine birds may experience chronic physiological stress from sublethal exposure to or intake of debris-related contaminants or discarded debris associated with OCS oil- and gas-related activities. This may result in disturbances to and displacement of single birds or in some cases entire flocks. Much of the floating material discarded from vessels and structures offshore presumably drifts ashore, remains within coastal waters, or eventually sinks. These materials may include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest overall damage to birds (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS; Tasker et al., 2000; Dau et al., 2009; Ryan et al., 2009).

It is believed that coastal and marine birds are less likely to become entangled in or ingest OCS oil- and gas-related trash and debris as a result of BSEE's regulations (NTL 2012-BSEE-G01) regarding the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR § 250.300(c)). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of any plastics at sea or in coastal waters (effective January 1, 1989).

Non-OCS Oil- and Gas-Related Impacts

There are no mitigations in place that consider potential non-OCS oil- and gas-related effects on avian resources due to climate change and habitat impacts. A Memorandum of Understanding between this Agency and FWS regarding the conservation of migratory birds was signed in June 2009 (USDOI, FWS and USDOI, MMS, 2009).

Non-OCS Oil- and Gas-Related Air Pollutants

Air pollutants include the amount of sulfur dioxide (and other regulated pollutants; refer to **Chapter 4.1.1.1** of this Supplemental EIS, Chapter 4.2.1.1 and Table 4-1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.1 of the WPA 233/CPA 231 Supplemental EIS) expected to be released due to a CPA proposed action, as well as from prior and future OCS lease sales, and State oil and gas activity. These pollutants may adversely affect coastal and marine birds and their habitats (**Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS). Pollutant emissions into the atmosphere from the activities under the non-OCS oil- and gas-related cumulative analysis are expected to have minimal effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations, as regulated by USEPA (Wilson et al., 2010, Tables 8-1 and 8-2). Emissions of pollutants into the atmosphere under the non-OCS oil- and gas-related cumulative analysis are projected to have minimal effects on onshore air quality because of the atmospheric regime, emission rates (Table 4-1 of the 2012-2017 WPA/CPA Multisale EIS), and the distance of these emissions from the coastline. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} under the non-OCS oil- and gas-related cumulative analysis are estimated to be less than PSD Class I and Class II allowable increments for the respective subareas as per both the steady-state and plume dispersion analyses, and they are assumed to be below concentrations that could harm coastal and marine birds (**Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS; also refer to Newman, 1979, and Newman and Schreiber, 1988).

For coastal and marine birds, direct impacts (on individuals) and indirect impacts (on habitat or food supply) due to air quality under the non-OCS oil- and gas-related cumulative analysis may include chronic, sublethal effects leading to overall reduced recruitment. Nevertheless, these impacts would not be expected to rise to population-level impacts across the GOM.

Habitat Loss, Alteration, and Fragmentation Associated with Commercial and Residential Construction and Industrial Growth

Habitat loss, alteration, and fragmentation has the potential to affect all aspects of an avian community's annual life cycle and the overall population size for some species of birds that occur in the Gulf of Mexico (Arlt and Pärt, 2007). Much habitat loss, alteration, and fragmentation occurs in the nearshore environment or onshore and is not OCS oil- and gas-related, e.g., commercial and residential construction and industrial development. Non-OCS oil- and gas-related impacts on habitat operate in a way similar to the OCS oil- and gas-related impacts on habitat discussed previously in this chapter. Cumulative activities will stress individuals and their populations, causing them to avoid or emigrate from traditional breeding, feeding, or wintering areas or alter migratory routes. Some of the species may be declining (Table 4-14 of the 2012-2017 WPA/CPA Multisale EIS) and are further being displaced from areas along the coast (and elsewhere) as a result of the destruction of or encroachment on their preferred habitat(s) (Andrén, 1994; Withers, 2002). As these birds emigrate to and settle in undisturbed areas of similar habitat (assuming it is available), their presence may increase intra- and interspecific competition for space and food (Goss-Custard, 1980).

Bird habitat loss, alteration, and fragmentation associated with commercial and residential development and industrial growth are probably occurring at a faster pace and on a spatial scale exceeding that compared with OCS oil- and gas-related activities. Avian species are adaptable with ephemeral settling patterns, but the pace with which they can adapt may be too slow compared with the pace with which human-induced habitat loss, alteration, or fragmentation is occurring across the U.S. (and Canada). This appears to be resulting in some species of breeding birds making poor "choices" (i.e., selecting habitats that negatively affect survival or fecundity; "sinks" or "traps"), at least in the short term (Clark and Shutler, 1999; Kristan, 2003; Battin, 2004). Delayed responses to habitat loss by some avian species are likely to occur when the rate of habitat loss or modification and/or environmental perturbation (e.g., climate change) exceeds the demographic potential of the population decoupling population dynamics from landscape dynamics (With et al., 2008). Habitat loss and fragmentation may be occurring at multiple spatial scales or across multiple areas, i.e., breeding, staging, and wintering, and therefore, connectivity of suitable habitats is reduced (Haig et al., 1998; Mönkkönen and Reunanen, 1999). Also, access to resources (either habitat itself or food resources) within these sites may be limiting or may become limiting. That is, resources are no longer available in sufficient quantities and/or of sufficient quality to meet the demands of migration and breeding (Goss-Custard et al., 2006; Newton, 2006; Skagen, 2006). Coastal habitat loss, alteration, and fragmentation are a major concern for those interested in managing these migratory bird populations (Erwin, 1996; USDOI, FWS, 2008; North American Bird Conservation Initiative, 2009). Development, both commercial and residential, was recognized as a major threat to remaining coastal habitats, ecological diversity, wildlife populations, and species persistence in the southeastern U.S. by Czech and Krausman (1997) and Czech et al. (2000).

Refer to **Chapter 4.1.1.4** of this Supplemental EIS, Chapters 4.2.1.4.1-4.2.1.4.3 of the 2012-2017 Multisale EIS, and Chapter 4.2.1.4 of the WPA 233/CPA 231 Supplemental EIS for more details regarding impacts to wetlands. Dahl (2006) estimated an annual loss rate of 5,540 ac (2,242 ha) for the intertidal estuarine and marine wetland class, mostly in Louisiana, from all impacting factors.

Tanker Oil Spills and Spills Related to Oil and Gas Activities in Coastal State Waters and Spill-Response Activities

Most offshore non-OCS oil- and gas-related spills occur from vessel and barge operations (Helm et al., 2008; Tables 3-8, 3-9, and 3-11 of the 2012-2017 WPA/CPA Multisale EIS). Based on the OSRA model for coastal spills ≥1,000 bbl, the estimated total number of spills is 3 per 6 years for the total of non-OCS oil- and gas-related sources; for offshore spills ≥1,000 bbl, the estimated total number of spills for non-OCS oil- and gas-related sources is ≤1 per year for tank ships and ≤1 per year for tank barges. In summary, the use of waterbird, marshbird, shorebird, and seabird feeding areas at the sea surface and at the intertidal wetland zone, where spilled oil tends to accumulate makes many avian species extremely vulnerable to spilled oil (Tables 4-8, 4-12, and 4-13 of the 2012-2017 WPA/CPA Multisale EIS). Oil spills in the cumulative case have the greatest potential impact to coastal and marine birds (e.g., Tables 4-8 and 4-15 of the 2012-2017 WPA/CPA Multisale EIS).

Oil-spill-related impacts on birds from the total cumulative scenario are expected to range from moderate to adverse, but not significant, in the absence of another major spill. The incremental increase of oil spills from a CPA proposed action to the total cumulative impacts is also expected to be moderate to adverse but not significant.

Pollution of Coastal Waters Resulting from Municipal, Industrial, and Agricultural Runoff and Discharge

There exists a wide variety of contaminant inputs into coastal waters bordering the Gulf of Mexico (USEPA, 2012a; USDOC, NOAA, 2011a). Non-OCS oil- and gas-related activities and natural processes that can impact marine water quality include bilge water discharges from large ships and tankers, and coastal pollutants that are transported away from shore, including municipal, industrial, and agricultural runoff, river input, sewerage discharges, industrial discharge, and natural seepage of oil and gas. Contaminants from non-OCS oil- and gas-related pollution of coastal waters resulting from runoff and discharge may have acute (single episode) or chronic (multiple episode) impacts to avian populations in the GOM and impacts may be lethal or sublethal. The dominant pollution source is the large volume of water from the Mississippi River, which drains over two-thirds of the contiguous United States, creating a seasonal zone of hypoxia offshore at the continental shelf (Rabalais et al., 2001, 2002a, and 2002b). 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, hydro-modification activities, large commercial waste disposal operations, livestock farming, manufacturing industry activities, power plant operations, and pulp and paper mills (Schmitt, 1998; White and Wilds, 1998). Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash and debris, and domestic and sanitary discharges. All of these factors, as well as sedimentation, greatly contribute to the diminishing water quality in the GOM and associated rivers and wetlands within the southeastern United States (USEPA, 2012a; USDOC, NOAA, 2011a). Refer to **Chapter 4.1.1.2** for more information on coastal water quality.

Aircraft and Vessel Traffic (Including Military Activities)

Helicopters may have more impact on bird behavior than airplanes, probably because of a much higher noise level associated with the prop wash (Komenda-Zehnder et al., 2003; Rojek et al., 2007). Military activities will include vessel and aircraft traffic. Ward et al. (1999) recommended that all aircraft follow not only the Federal Aviation Administration's (1984) minimum altitude of 610 m (2,000 ft) but also adopt a lateral buffer distance of 1.6 km (~1 mi). Based on results for disturbance to wintering waterbirds (mostly ducks), Komenda-Zehnder et al. (2003) recommended minimum flight altitudes (above sea level) of 450 m (1,476 ft) for helicopters and 300 m (984 ft) for airplanes. Disturbance effects (e.g., air and vessel traffic) can have variable impacts to avian populations depending on the type, intensity, duration, distance to and frequency of the disturbance, as well as due to species-specific differences in tolerance levels (Blumstein, 2006; Blumstein et al., 2005; Wright et al., 2010). Disturbance-related impacts typically result in behavioral changes, decreasing available habitat, and decreases in reproductive effort or nest success. In the CPA, disturbance impacts from helicopter traffic and service vessels (**Tables 3-2 and 3-4** of this Supplemental EIS and Table 3-13 of the 2012-2017 WPA/CPA Multisale EIS) represent incremental increases to the total cumulative scenario. Impacts to affected avian populations are expected to range from negligible to moderate (**Chapter 4.1.1.16** of this Supplemental EIS, Chapters 4.2.1.16.1-4.2.1.16.3 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS).

Nonconsumptive and Consumptive Recreation

Impacts of nonconsumptive recreation depend on many factors, including species and type of recreation and associated disturbance. Even visitation by those most interested in conserving wildlife may result in birds abandoning areas that wildlife managers are trying to protect (Burger and Gochfeld, 1998; Klein, 1993). Ecotourists (including bird watchers and wildlife photographers) and outdoor recreationists are not likely to be aware of the negative impacts that their presence may have on wildlife (Carney and Sydeman, 1999). Ecotourists can introduce high levels of disturbance to nesting waterbird colonies (Rodgers and Schwikert, 2002 and 2003). Ecotourists often closely approach birds, return to the same sites repeatedly, and visit sites year-round.

Energy cost in birds is highest for flight. Fleeing from disturbance may affect feeding behavior and the effects of predation in complex ways; staying put may increase or decrease fitness.

Recreational vessel traffic is assumed to be a much greater source of impact to birds in coastal habitats relative to those offshore.

Despite the number of waterfowl killed annually (consumptive recreation) under Federal hunting laws, duck and goose populations remain strong.

For additional discussion on the topic, refer to **Chapter 4.1.1.14** of this Supplemental EIS, Chapter 4.1.1.14.1 of the 2012-2017 Multisale EIS; and Chapter 4.1.1.14 of the WPA 233/CPA 231 Supplemental EIS.

Maintenance and Use of Navigation Waterways

Adverse impacts related to the construction of navigation canals for oil and gas development in State waters and for commercial shipping and recreational/fishing boat traffic have generated substantial impacts to coastal wetlands (Ko and Day, 2004; Morton et al., 2006; Day et al., 2007; Figures 3-5 and 3-7 of the 2012-2017 WPA/CPA Multisale EIS). Initial impacts are locally substantial but largely limited to where canals and channels pass through wetlands. Periodic maintenance dredging is necessary and expected in existing non-OCS oil- and gas-related navigation channels through barrier passes and associated bars (Johnston et al., 2009). Much of the impact from State oil and gas development on coastal wetlands has already occurred. The continued long-term effects of saltwater intrusion, wind and wave action from storms, and erosion from wave action created by State oil- and gas-related, commercial shipping, and recreational vessel traffic and recreational/commercial fishing boats continue to take their toll on coastal salt marshes and associated wildlife and fisheries communities in the Gulf Coast region (Gosselink et al., 1998). From 1998 through 2004, wetland losses from all causes for all coastal wetland types were estimated at 442,200 ac (178,952 ha) (Stedman and Dahl, 2008; Engle, 2011, Table 1).

Collisions of Coastal and Marine Birds with Various Anthropogenic Structures

Wide-scale, long-term, standardized and systematic assessments of bird collisions with manmade structures are limited (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS; Erickson et al., 2001). The most important structural features related to collision risk may be size, height, light intensity, and light color associated with a given structure (Bevanger, 1994 and 1998). No hypotheses for the apparent attraction of birds, especially nocturnally migrating songbirds, to lights have been conclusively supported (Drewitt and Langston, 2008; Martin, 2011). The placement of elevated structures along migration corridors appear to be particularly problematic for birds, resulting in increased collision risk and collision-related mortality. Warning lights for aircraft on towers >200 ft (61 m) are mandatory in the United States (Drewitt and Langston, 2008). Combining collision mortality estimates for communication towers, power lines, and window strikes, the total mortality may be approaching 1 billion birds killed annually (Manville, 2005a and 2009; Klem, 2009).

Predation

Predation, although a natural process, can be a threat to coastal and marine birds if predator populations are artificially high, non-native predators are introduced, or predators have easier access to nesting sites because of human activities.

Domestic cats have become an increasingly devastating introduced predator in many ecological systems throughout the world. In the U.S. alone, estimates based on the number of domestic cats multiplied by average annual bird mortality per cat results in estimates of 468 million to 8.4 billion birds killed (Dauphiné and Cooper, 2009 and 2011; Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS). The lower range would place domestic cat mortality second only behind collisions with windows/buildings (Klem, 2009), whereas if the upper range even remotely approximates reality, then domestic cat-related mortality would far exceed all other anthropogenic sources of avian mortality. Domestic cats are especially important predators on land birds that are trans-Gulf migrants, preying on them while they are on land.

A study done on the Isle Dernieres barrier island complex in Louisiana suggests that colonial nesting seabirds are impacted on some barrier island breeding habitat by raccoon, rat, and coyote predation on eggs and young (Leumas, 2010).

Diseases

Throughout North America, avian mortality associated with diseases, broadly defined here to include lead poisoning, probably results in the death of millions of birds annually (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS). Friend and Franson (1999) list seven broad classes of primarily avian diseases and under each are varying numbers or kinds of specific diseases. The most commonly diagnosed viral diseases were duck plague, paramyxovirus, and West Nile virus, together causing almost all deaths due to infectious diseases; fungal and parasitical infections were relatively minor (Newman et al., 2007). The impact of influenza viruses on wild animal host survival, reproduction, and behavior are almost completely unknown (Vandegrift et al., 2010). LaDeau et al. (2007) stated that "Emerging infectious diseases present a formidable challenge to the conservation of native species in the twenty-first century." Avian diseases may become an increasingly important mortality factor to consider, particularly since environmental contaminants are prevalent in many ecosystems, and in some cases avian populations may be occurring at densities promoting the spread of diseases. Though the level of mortality associated with most diseases is unknown, avian death due to various diseases is likely in the millions annually. Many diseases are more easily spread amongst individuals at high densities, e.g., botulism in molting waterfowl.

Climate Change and Related Impacts

In general, climate change as it relates to migratory birds may impact certain species in myriad ways. Effects may manifest themselves through relatively "simple" range contractions or expansions, either elevationally or latitudinally. The relatively recent overlap of species previously segregated in space or by microhabitat features may increase interspecific competition for resources, which may lead to changes in species composition and abundance. In some cases where long-term data are available, results unequivocally demonstrate phenological changes like earlier nesting (Møller et al., 2008). Declines happened in species that had not changed the timing of nesting in response to changing environmental conditions (Møller et al., 2008). It is possible that species that cannot adapt relatively rapidly could incur temporal mismatches (Visser et al., 1998 and 2004). Before climate change, timing of departure from the wintering grounds tended to be optimized such that peak arrival and/or peak hatching overlapped the peak in food resource availability.

Impacts from predicted sea-level rise will affect the availability and distribution of preferred habitats. Many species of birds are closely linked to shallow-water habitats, primarily for food resources (e.g., marshbirds, waterbirds, and shorebirds) but also for nesting. Numerous species of coastal and marine birds are vulnerable to the effects associated with climate change (North American Bird Conservation Initiative, 2010). In particular, those species that select low-lying habitats such as islands, beaches, flats, dunes, sand bars, gravel bars, dredge spoils, shorelines, estuaries, and similar inshore habitat are particularly vulnerable due to annual increases in sea level. Sea-level rise is expected to inundate much of the low-lying areas and also increase water depths in areas farther inland. As the sea-level rises, impacts from storm surges and flooding will extend farther inland. Also, saltmarsh obligate species (e.g., seaside sparrow, Nelson's sharp-tailed sparrow, yellow rail, black rail, clapper rail, and king rail) are also extremely sensitive to loss of salt marsh habitat. Other climate change impacts include increasing sea-surface temperature and the increasing frequency and intensity of storms (and associated erosion) (Michener et al., 1997). Effects from these various factors will most likely dramatically alter the species composition and abundance, as well as the distribution of potentially affected species primarily due to major reductions in available habitat and zones shifting inland and secondarily to changes in the distribution and abundance of preferred foods.

Storms and Floods

Coastal storms and hurricanes can often result in the direct mortality of many species of birds, but likely the larger impact is to the habitat on which the populations rely. Associated storm surges and flooding can destroy active nests and force birds into suboptimal habitats. Nesting territories and colonial waterbird and marshbird rookeries with optimum food and/or nest-building materials may also be destroyed. Species reliant on the beaches, flats, islands, sand bars, gravel bars, dredge spoil-piles, shorelines, estuaries, and other coastal low-lying features for nesting are particularly vulnerable to habitat loss or alteration associated with such storms (USDOI, FWS, 2010). Elevated levels of municipal, industrial, and agricultural pollutants in coastal wetlands and waters will probably expose greater numbers of resident breeding birds and wintering migrants to chronic physiological stress due to these contaminants being redistributed across the landscape as a result of storms and flooding (Burger and Gochfeld, 2001).

Hurricane-related impacts to birds are provided in more detail in **Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS.

Fisheries Interactions

Commercial fisheries may incidentally entangle and drown or otherwise injure birds during fishing operations or due to lost or discarded fishing gear (Manville, 2005b; Bull, 2007; Brothers et al., 2010). Avian mortality estimates associated with commercial fisheries (i.e., seabird bycatch) is likely on the order of high thousands to low millions (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS). Both NMFS and FWS have taken proactive steps to mitigate these losses through modifications to the equipment used, fishery closures in certain areas, time-of-year and time-of-day closures by some states, and use of fishery observers (Melvin et al., 1999 and 2001; Cooper et al., 2001). With these recent changes in policy, procedures, and techniques, cumulative impacts to future bird bycatch of longline fisheries on marine birds in the northern Gulf of Mexico should be much reduced. There is likely overlap between many species of seabirds, their prey, and some fisheries. Fisheries may impact certain seabird populations by removing preferred prey or may alter trophic dynamics by removing top-level predators (e.g., bluefin and yellowfin tuna) (Furness, 2003). In addition, substantial quantities of bycatch (i.e., nontarget species + offal + discards) are discarded as waste overboard, and though detrimental to the ecosystem as a whole (Crowder and Murawski, 1998; Harrington et al., 2005), may actually benefit some species of seabirds (Furness, 2003; Votier et al., 2004). Overharvest of some fish populations, particularly top-level predatory fishes, appears to be occurring at unprecedented levels worldwide (Myers and Worm, 2003). Unfortunately, the loss of these top-level predators can have unknown and potentially dramatic effects on marine food-web dynamics and the ocean ecosystem as a whole, including seabird populations reliant on various species of smaller prey fish (Furness and Camphuysen, 1997; Piatt et al., 2007).

Trash and Debris

Coastal and marine birds may experience chronic physiological stress from sublethal exposure to or intake of debris-related contaminants or discarded debris associated with non-OCS oil- and gas-related activities. This may result in disturbances to and displacement of single birds or in some cases entire flocks. Much of the floating material discarded from State oil and gas vessels and structures offshore as well as recreational debris presumably drifts ashore, remains within coastal waters, or eventually sinks. These materials may include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest overall damage to birds (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS; Tasker et al., 2000; Dau et al., 2009; Ryan et al., 2009).

It is believed that coastal and marine birds are less likely to become entangled in or ingest non-OCS oil- and gas-related trash and debris as a result of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters (effective January 1, 1989).

Summary and Conclusion

Human-induced disturbance effects often tend to get overlooked or underestimated as a potential population-limiting factor for birds. The cumulative effect on coastal and marine birds from all sources is expected to result in changes in species composition and distribution and in a discernible decline in the number of birds that form localized groups or populations. Some of these changes are expected to be permanent and possibly result from impacts to and declines in critical habitat for some endangered species. However, the incremental contribution of a CPA proposed action to the cumulative impact is considered adverse but not significant because the effects of the most probable impacts, such as lease sale-related operational discharges and helicopters and service-vessel noise and traffic, are expected to be sublethal; and some displacement of local individuals or flocks may occur to other habitat, if available.

In general, the net effect of habitat loss from oil spills, OCS pipeline landfalls, and maintenance and use of navigation waterways, as well as habitat loss and modification resulting from coastal facility construction and development, will probably reduce the overall carrying capacity of the disturbed habitat(s). That is, impacted habitats may result in reductions to both species composition (fewer species) and abundance (lower numbers) as compared with what the area supported historically. These would be the most serious cumulative impacts on birds.

Nocturnal circulation events at platforms are assumed to have mostly sublethal impacts on migrating bird populations. However, oil and gas platforms in the GOM (and associated lighting) result in collision-related mortality of 200,000-321,000 birds/year (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS); these numbers will increase as a result of a CPA proposed action. Overall, offshore oil and gas platform-related avian mortality, though representing an additional source of human-induced mortality, represents a small fraction compared with other sources of human-induced mortality. The mortality estimates related to offshore oil and gas activities are well below that for vehicles, buildings and windows, power lines, and communication towers.

The *Deepwater Horizon* explosion and spilled oil that made it into the nearshore and coastal environment resulted in the loss of ~7,250 birds based on counts of dead and/or oiled birds (Table 4-2 of the WPA/CPA 231 Supplemental EIS). This is a low estimate because many individuals were not collected. In addition, spill-response activities likely exacerbated impacts, particularly for breeding birds nesting on the beaches, barrier islands, and other habitats that were intensively monitored. The total number of birds killed by the *Deepwater Horizon* explosion, oil spill, and response was likely biased low. In addition, it will be years before a reliable, model-based estimate of mortality that accounts for detection-related issues is provided. At present, the best available information does not provide a complete understanding of the effects of the spilled oil or the recovery potential for the most impacted species. Unavailable information on the effects on birds, including from the *Deepwater Horizon* explosion, oil spill, and response (and thus changes to the birds baseline in the affected environment), makes an understanding of the cumulative effects less clear. Here, BOEM concludes that the unavailable information from this event may be relevant to foreseeable significant adverse impacts to birds. Relevant data on the status of seabird populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and based upon accepted methods and approaches. Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this Supplemental EIS (including the No Action and an Action alternative) for the following reasons. The CPA is an active oil and gas region with ongoing (or the potential for) exploration, drilling, and production activities. In addition, non-OCS oil- and gas-related activities will continue to occur in the CPA irrespective of a CPA proposed action (e.g., fishing, military activities, and scientific research). The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), routine activities, accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this Supplemental EIS. Impacts on birds from either smaller accidental events or low-probability catastrophic events will remain the same.

Disease is often lethal and may take millions of birds annually, but it should be considered a "naturally" occurring avian mortality factor unless the pathogen is introduced by humans. Storms and floods represent natural, often major disturbances to which exposed organisms are generally adapted. An exception would be hurricane-related storm surges, which are exacerbated by coastal wetland loss in Louisiana and throughout the northern GOM. Effects from sea-level rise may be particularly severe for many species of breeding marsh- and shorebirds as well as several species of wintering shorebirds that rely on beaches, flats, dunes, sandbars, gravel bars, shorelines, islands, estuaries, and other low-lying, tidally influenced habitats in the Gulf of Mexico . Even a nominal rise in sea level would inundate much of this habitat, making it unsuitable for many, if not most, of these species.

In conclusion, the incremental contribution of a CPA proposed action to the cumulative impact is considered adverse but not significant when compared with the impacts of non-OCS Program-related factors.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A detailed treatment of the potential effects of impact-producing factors on coastal and marine birds associated with a CPA proposed action can be found in Chapters 4.2.1.16.2 and 4.2.1.16.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS. A search of Internet information sources (recent publications on NOAA's, USGS's, and FWS's websites), as well as recently published journal articles, was conducted to determine the availability of recent information on coastal and marine birds. New information pertinent to the consideration of the red knot (*Calidris canutus rufa*) as a federally threatened species was discovered.

The red knot (*Calidris canutus rufa*) is presently considered a Federal candidate species. It was originally (September 2006) considered as a Category 6 Candidate, but it was upgraded (more urgently) to a Category 3 Candidate in December 2008. As of September 30, 2013, FWS proposed to list the rufa red knot (*Calidris canutus rufa*) as a threatened species (USDOI, FWS, 2014). Three of the six subspecies of red knot occur in North America, all three of which breed in the Arctic (central Canadian Arctic and on the north coast of Alaska from the Seward Peninsula to the Canadian border). It uses coastal beaches, bays, tidal flats, salt marshes, and lagoons primarily along the Atlantic Coast (a major stopover is in Delaware Bay) during spring and fall migration in transit from its breeding grounds in the Arctic to its wintering grounds at Tierra del Fuego, Argentina, and back. Rather steep declines (~505 between the late 1980's and 2003; Morrison et al., 2004) have been observed in the population that departs the central Canadian Arctic in August, embarking on a 15,000-km (9,321-mi) migration to northern Brazil and Tierra del Fuego, Argentina (Morrison et al., 2006; Niles et al., 2008). During the fall migration, this population stops on its way south in Delaware Bay where individuals almost exclusively consume (and require) large quantities (both in number and volume) of horseshoe crab (*Limulus polyphemus*) eggs to fatten-up prior to departure (Harrington, 2001). On the spring return flight, these same birds spend ~2 weeks in the same general area in an effort to recover energy lost (some as much as 30% lighter) during the migration from the wintering grounds (Niles et al., 2008). This is the single most important staging area for this population of red knots. There has been a major increase in the commercial fishing harvest of adult horseshoe crabs, likely resulting in major reductions in availability of the species that produce the eggs on which the red knots rely (Karpanty et al., 2006; Wells, 2007).

The FWS received its first petition to list this species on August 9, 2004, with two additional petitions, both received on August 5, 2005. The associated formal review, which was completed on September 12, 2006 (*Federal Register*, 2006b), indicated a listing priority of 6. Subsequently, FWS has completed formal reviews for this species in 2007 (December 6, 2007; *Federal Register*, 2007), 2008 (December 10, 2008; *Federal Register*, 2008a), 2009 (November 9, 2009; *Federal Register*, 2009), and 2010 (November 10, 2010; *Federal Register*, 2010). As indicated above, it is now considered a Category 3 Candidate species and is currently being considered to list as threatened (*Federal Register*, 2013f).

Within the Gulf of Mexico region, wintering birds are found primarily in Florida, but the species has also been observed in Texas (e.g., Bolivar Flats), Louisiana (e.g., barrier islands and headlands along the coast), Mississippi, and Alabama (e-Birds, 2013), and it is considered a State Species of Conservation Concern in Florida and Mississippi. Apparently, the numbers of wintering and staging red knots using coastal beaches in Gulf Coast States other than Florida have declined dramatically; now more are found along the Gulf and Atlantic Coasts of Florida and the Atlantic Coast of Georgia and South Carolina (Harrington, 2001; Niles et al., 2008, Figures 8-9 and 11). Both natural (i.e., hurricanes, subsidence, and saltwater intrusion) and anthropogenic (i.e., coastal development, oil and gas infrastructure onshore, and disturbance) factors influencing coastal wetlands and associated barrier island and beach habitats on the wintering and staging areas in the southeastern U.S. may be contributing to the change in distribution (and possibly population declines) of red knots over time (Wells, 2007; Niles et al., 2010).

The *Deepwater Horizon* explosion, oil spill, and response activities that made it into the nearshore and coastal environment resulted in the loss of ~7,250 birds across all Gulf of Mexico planning areas (Table 4-2 of the WPA 233/CPA 231 Supplemental EIS). In addition, spill-response activities likely exacerbated impacts, particularly for breeding birds nesting on the beaches, barrier islands, and other habitats that were intensively monitored. The total number of birds killed by the *Deepwater Horizon* explosion, oil spill, and response was likely biased low (Table 4-2 of the WPA 233/CPA 231 Supplemental EIS). In addition, it will be years before a reliable, model-based estimate of mortality that accounts for detection-related issues is provided (e.g., Flint et al., 1999; also refer to Byrd et al., 2009). At present, the best available information (e.g., Henkel et al., 2012) does not provide a complete understanding of the effects of the spilled oil or the recovery potential for the most impacted species (Tables 4-12, and 4-13 of the 2012-2017 WPA/CPA Multisale EIS and Table 4-2 of the WPA 233/CPA 231 Supplemental EIS).

Unavailable information on the cumulative effects to coastal and marine birds, including information from after the *Deepwater Horizon* explosion, oil spill, and response (and thus related changes to the avian baseline in the affected environment), makes an understanding of the potential impacts from a CPA proposed action less clear. BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to coastal and marine birds. Nevertheless, relevant data on the status of bird populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze through the NRDA process, and impacts from the *Deepwater Horizon* explosion and oil spill may be difficult or impossible to discern from other factors. It is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis based upon accepted methods and approaches. However, BOEM believes that this incomplete or unavailable information regarding effects of the *Deepwater Horizon* explosion, oil spill, and response on birds (refer to Table 4-2 of the WPA 233/CPA 231 Supplemental EIS) would not likely be essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Compared with non-OCS Program factors, such as habitat loss, collisions with non-OCS oil- and gas-related structures, disease, and other anthropogenic factors, which may result in billions of bird deaths per year, the incremental effect of a

CPA proposed action is particularly small. Any information obtained from the *Deepwater Horizon* explosion, oil spill, and response is unlikely to be so significant as to change the relative importance of non-OCS oil- and gas-related factors to bird populations (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS and Table 4-2 of the WPA 233/CPA 231 Supplemental EIS).

4.1.1.17. Gulf Sturgeon

BOEM has reexamined the analysis for Gulf sturgeon presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for Gulf sturgeon presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of Gulf sturgeon and the full analyses of the potential impacts of routine and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.17 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.17 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below, as well as any new information that has become available since those documents were published.

The following information is a summary of the resource description incorporated from the 2012-2017 WPA/CPA Multisale EIS, WPA 233/CPA 231 Supplemental EIS, and any new information that has become available since these documents were published. Gulf sturgeon were federally listed as threatened on September 30, 1991. A recovery plan was subsequently developed and critical habitat was designated on April 18, 2003. Threats to this anadromous species include overfishing and habitat destruction. Historically, Gulf sturgeon were commercially harvested, which dramatically declined population numbers. Subsequent dam construction intensified habitat loss and restricted access to historic spawning areas. Designated critical rivers and their associated estuaries include the Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and the Suwannee Rivers. Migration areas include the nearshore northern GOM from Lake Pontchartrain in Louisiana east to the Suwannee River in Florida. Although estimates are relatively imprecise, population trends have stabilized or shown slight increases in recent years at the riverine population scale (USDOI, FWS and USDOC, NMFS, 2009), suggesting that they may be making a slow comeback. Groups of Gulf sturgeon have been observed to remain for periods of time in foraging "holding areas," or in deeper, darker, slower-moving areas of rivers or estuaries (Sulak et al., 2012). Natural or other accidental catastrophes have the potential to be detrimental to Gulf sturgeon populations and their habitats.

Impacts of Routine and Accidental Events

A detailed impact analysis of the routine impacts of OCS activities associated with proposed CPA Lease Sales 235, 241, 247 on Gulf sturgeon can be found in Chapter 4.2.1.17.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.17 of the WPA 233/CPA 231 Supplemental EIS. Potential impacts to the threatened Gulf sturgeon and their designated critical habitat from routine activities associated with a CPA proposed action may occur from drilling and produced-water discharges, degradation of estuarine and marine water quality from infrastructure, dredging activities, vessel traffic, pipeline installation, and explosive platform removal. Designated Gulf sturgeon critical habitat is confined to State waters, and navigation channels are exempt from the critical habitat status. Most activities related to a CPA proposed action would occur in Federal waters (i.e., structure placement, drilling, removal, etc.). Though critical habitat may be impacted directly or indirectly, such impacts are expected to be negligible due to the distance of Gulf sturgeon habitat and life cycles from most activities related to a CPA proposed action.

Potential routine impacts on Gulf sturgeon and their designated critical habitat may occur from drilling and produced-water discharges, bottom degradation of estuarine and marine water quality by nonpoint runoff from estuarine OCS oil- and gas-related facilities, vessel traffic, pipeline installation, and explosive removal of structures. Because of the permitted discharge limits mandated and enforced in the Federal and State regulatory process, the dilution and low toxicity of this pollution is expected to result in negligible impacts of a CPA proposed action on Gulf sturgeon. Vessel traffic would generally only pose a risk to Gulf sturgeon when the vessels are leaving and returning to port. Major navigation channels are excluded from critical habitat. Also, the Gulf sturgeon's characteristics of bottom-feeding and general avoidance of disturbance make the probability of vessel strikes extremely remote. If pipeline is installed nearshore as a result of a CPA proposed action, regulatory permit requirements governing pipeline placement and dredging, as well as recent noninvasive techniques for locating pipelines, would result in a minimal impact to the Gulf sturgeon's critical habitat. Explosive removal of structures as a result of a CPA proposed action would occur well offshore of the Gulf sturgeon's critical habitat and the riverine, estuarine, and shallow Gulf habitats where sturgeon are generally located. There is no publicly available data indicating that sturgeons are using the deeper Gulf waters where most of the OCS activities occur. In general, the mud substrates found in the Gulf waters do not support the appropriate benthic food source for Gulf sturgeon. Due to regulations, mitigations, and the distance of routine activities from known Gulf sturgeon habitats, impacts from routine activities of a CPA proposed action would be expected to have negligible effects on Gulf sturgeon and their designated critical habitat.

Potential accidental impacts on Gulf sturgeon and the designated critical habitat may occur primarily from oil spills. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241 and 247 on Gulf sturgeon can be found in Chapter 4.2.1.17.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.17 of the WPA 233/CPA 231 Supplemental EIS

Unusually low tidal events, increased wave energy, or the use of oil dispersants increases the risk of impact with bottom-feeding and bottom-dwelling fauna. For this reason, dispersants are not expected to be used with coastal spills. Winds and currents would 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 would potentially impact the coastal Gulf sturgeon critical habitat.

The potential risk to sturgeon would result from either direct contact with oil spills (or the potential PAH's introduced through the spill) or, in some cases, long-term exposure to produced water, or water associated with extraction process. The PAH's could also reach the Gulf sturgeon through its diet of benthic invertebrates; PAH's can accumulate in invertebrates (USDOI, GS, 2012a). The likelihood of Gulf sturgeon impacts in coastal waters as a result of OCS activity is reduced by both the distance from a potential spill or production area and the concentration of contaminants that actually reach the area of sturgeon activity. Except for oil spills in the nearshore environment, the Gulf sturgeon would be at greater risk of a PAH encounter from sources other than the OCS during the inland river migrations due to the industrial and farm waste introduced into these coastal rivers from the adjacent agricultural and urban land use.

If there is contact with spilled oil, it could have detrimental physiological effects on Gulf sturgeon. In the rare event contact with oil occurs, this could cause nonlethal effects, including causing the fish to temporarily migrate from the affected area, irritation of gill epithelium, an increase of liver function in a few adults, and possibly interference with reproductive activity. The juvenile and subadult Gulf sturgeon, at a minimum, seasonally use the nearshore coastal waters and could potentially be at risk from both coastal and offshore spills. Due to the distance of the activity from shore and Gulf sturgeon critical habitat, there is a minimal risk of any oil coming in contact with Gulf sturgeon from an offshore spill. For a low-probability catastrophic spill, the proximity, type of oil, weather conditions, as well as the amount and location (distance offshore and water depth) of the dispersant treatment, may contribute to the severity of the spill's impact to the sturgeon and its habitat (for more information regarding a low-probability catastrophic spill, refer to **Appendix B**).

Summary and Conclusion

BOEM has reexamined the analysis for Gulf sturgeon presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information provided above. Various Internet sources were examined to assess recent information regarding this resource that may be pertinent to a CPA proposed action. No new significant information was discovered that would alter the impact conclusion for these Gulf sturgeon presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017

WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241 and 247.

The incremental contribution of a CPA proposed action to the cumulative impacts on Gulf sturgeon is negligible. This is because the effect of contact between lease sale-specific oil spills and Gulf sturgeon is expected to be sublethal, and regulations and mitigations decrease impacts from routine events. Other non-OCS oil- and gas-related activities, including storms and anthropogenic factors on habitat, are expected to result in more incremental and cumulative impacts to this species.

Cumulative Impacts

Background/Introduction

This cumulative analysis summary considers the impacts of all past, present, and reasonably foreseeable future activities plus the contribution of a CPA proposed action that may adversely affect Gulf sturgeon within its range and critical habitat in the northern Gulf of Mexico. The cumulative impacts from routine OCS oil- and gas-related, impact-producing factors considered in this cumulative analysis include oil spills. Potential non-OCS oil- and gas-related impact-producing factors considered in this analysis include natural catastrophes, fishing, and other factors that can result in changes to habitats.

OCS Oil- and Gas-Related Impacts

Gulf sturgeon could be impacted by oil spills resulting from a CPA proposed action. The effects on Gulf sturgeon from contact with spilled oil would be sublethal (Berg, 2006). Other potential impacts may occur from drilling and produced-water discharges, bottom degradation of estuarine and marine water quality by nonpoint runoff from estuarine OCS oil- and gas-related facilities, vessel traffic, pipeline installation, and explosive removal of structures. However, these impacts are expected to have negligible effects on Gulf sturgeon and their designated critical habitat, and will not be discussed as part of the cumulative impacts analysis.

Currently, there is little public data to ascertain the short-term and long-term effects of the *Deepwater Horizon* explosion, oil spill, and response on the Gulf sturgeon or its critical habitat. It is known that its critical habitat was exposed to oil and could possibly have been repeatedly exposed to oil in some cases. Until rigorous analysis on the quantity, type, and toxicity of the oil and where its spatial subsurface location is performed, no assessment can be made to the benthic forage base of the Gulf sturgeon. In addition, the oil underwent evaporation and was quickly emulsified and diluted at the wellhead by dispersants, which made it readily available for biodegradation.

Because of the low probability of an offshore oil spill from a CPA proposed action occurring and contacting Gulf sturgeon critical habitat (≤4%; Figure 3-22 of the 2012-2017 WPA/CPA Multisale EIS), Gulf sturgeon contact with oil is expected to be minimal. The amount of oil projected to spill with a coastal spill is small, and it would have localized effects. For a more detailed analysis of low-probability catastrophic spills, refer to **Appendix B**.

Non-OCS Oil- and Gas-Related Impacts

The Gulf sturgeon and its critical habitat can be cumulatively impacted by natural catastrophes, commercial fishing, State oil and gas activities, and other factors that can result in habitat changes. Recent climate trends and projections indicate more frequent and higher intensity storms, flooding, droughts, coastal erosion, and rising sea levels (Parry et al., 2007), all of which could impact Gulf sturgeon critical habitat, spawning areas and life history stages. Other naturally occurring events that can impact Gulf sturgeon may increase, such as the 1999 and 2005 red tides in Choctawhatchee Bay that resulted in sturgeon deaths (USDOI, FWS, 2000; State of Florida, Dept. of Environmental Protection, 2012) or El Niño/La Niña events, which can cause fish to extend their range (USDOC, NOAA, 2013d). Deaths of adult sturgeon and potential habitat alterations are expected to occur from commercial fishing. Non-OCS oil- and gas-related accidental spills can happen, such as the 2008 industrial spill in the Pearl River in Louisiana that resulted in the mortality of juvenile and adult Gulf sturgeon (USDOI, FWS, 2011b) and the February 2013 spill of wastewater from a water pollution control plant into the Withlacoochee River in Georgia (Schaefer, 2013). While these events have happened recently and there is ongoing monitoring of the impacted areas, it is unknown how the related mortalities affect the Gulf sturgeon population.

BOEM does not regulate State oil and gas activities, which could result in potential cumulative impacts to Gulf sturgeon from oil spills, drilling and produced-water discharges, and bottom degradation from dredging and vessel traffic all near the coast. These activities generally occur in the marine and higher salinity estuarine coastal waters and not in the rivers and holding areas that the Gulf sturgeon frequent. Coastal land uses are not expected to affect Gulf sturgeon directly because of the protection set by critical habitat designation. However, upstream urbanization and commercial or residential development can adversely affect the water quality downstream and therefore can have potential cumulative impacts to Gulf sturgeon.

A CPA proposed action would not require dredging near natal rivers used as migratory routes to upstream spawning areas. While there could be a need for maintenance dredging not directly related to OCS oil- and gas-related activities in the nearshore waters, juvenile or adult sturgeon using these areas have the ability to avoid the regulated dredging activity.

On August 8, 2013, a notice of issuance of permits was published in the *Federal Register* for take of Gulf sturgeon for scientific research (*Federal Register*, 2013f). Substantial damage to Gulf sturgeon critical habitat is expected from natural catastrophes and inshore alteration activities, such as dam building or maintenance dredging. As a result, it is expected that the Gulf sturgeon would experience a decline in population sizes and a displacement from their current distribution that would last more than one generation. Non-OCS oil- and gas-related impacts are seen as the primary cumulative impacts on Gulf sturgeon, compared with a CPA proposed action, even in light of incomplete or unavailable information.

Summary and Conclusion

BOEM has reexamined the analysis for Gulf sturgeon presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information provided above. Various Internet sources were examined to assess recent information regarding this resource that may be pertinent to the CPA. No new significant information was discovered that would alter the impact conclusion for these Gulf sturgeon presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The incremental contribution of a CPA proposed action to the cumulative impacts on Gulf sturgeon is negligible. This is because the effect of contact between lease sale-specific oil spills and Gulf sturgeon is expected to be sublethal, and regulations and mitigations decrease impacts from routine events. Other non-OCS oil- and gas-related activities, including storms and anthropogenic factors on habitat, are expected to result in more incremental and cumulative impacts to this species.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search was conducted for information published on Gulf sturgeon, and various Internet sources were examined to determine any recent information regarding this species. Sources investigated include BOEM, NMFS, FWS, USGS, IPCC, Florida Fish and Wildlife Conservation Commission, American Fisheries Society, State environmental agencies, current news events, and coastal universities. Other websites from scientific publication databases were checked for new information using general Internet searches based on major themes. No new significant information relevant to the above analysis was discovered since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The NRDA team has completed an assessment plan for nearshore resources following the *Deepwater Horizon* explosion, oil spill, and response. The goals set forth are to characterize the extent and distribution of nearshore sediment oiling, to model exposure of organisms in the water column and benthos to hydrocarbons in nearshore sediments, and to evaluate and quantify injury to nearshore benthic organisms (USDOC, NOAA, 2012a). Workplans for this assessment can be found on NOAA’s website (USDOC, NOAA, 2013c). Analyses of available data are unavailable.

BOEM acknowledges that there remains incomplete or unavailable information on Gulf sturgeon, including potential impacts from the *Deepwater Horizon* explosion, oil spill, and response (and thus changes to the Gulf sturgeon baseline in the affected environment). This makes an understanding of the affected environment and impacts from a CPA proposed action less clear. BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to Gulf sturgeon. Nevertheless, BOEM believes that this incomplete or unavailable information regarding the effects of the *Deepwater Horizon* explosion, oil spill, and response on Gulf sturgeon may be essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Relevant data on the status of Gulf sturgeon populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis (including data on related fish species) and applied this information based upon accepted scientific methods and approaches.

4.1.1.18. Fish Resources and Essential Fish Habitat

BOEM has reexamined the analysis for fish resources and essential fish habitat (EFH) presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for fish resources and EFH presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.18 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.18 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

A detailed description of fish resources and EFH can be found in Chapter 4.2.1.18 and Appendix D of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.18 of the WPA 233/CPA 231 Supplemental EIS. Also, EFH is discussed in the following chapters of this Supplemental EIS: water quality (**Chapter 4.1.1.2**); wetlands (**Chapter 4.1.1.4**); seagrass communities (**Chapter 4.1.1.5**); live bottoms (**Chapter 4.1.1.6**); topographic features (**Chapter 4.1.1.7**); *Sargassum* communities (**Chapter 4.1.1.8**); chemosynthetic deepwater benthic communities (**Chapter 4.1.1.9**); nonchemosynthetic deepwater benthic communities (**Chapter 4.1.1.10**); and soft bottom benthic communities (**Chapter 4.1.1.11**).

Impacts of Routine and Accidental Events

Effects on fish resources and EFH from routine activities associated with a CPA proposed action could result from coastal environmental degradation, marine environmental degradation, pipeline trenching, and offshore discharges of drilling muds and produced waters. A detailed impact analysis of the routine impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on fish resources and EFH can be found in Chapter 4.2.1.18.2 and Appendix D of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.18 of the WPA 233/CPA 231 Supplemental EIS. Since the majority of fish species within the CPA are estuary dependent, any modification of the coastal environment resulting from a CPA proposed action has the potential to adversely affect EFH and fish resources through the loss of nursery habitat or functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992). Although the potential exists, it is expected that any possible coastal and marine environmental degradation from a CPA proposed action would have little effect on fish resources or EFH.

With a CPA proposed action, BOEM projects no new coastal infrastructure with the exception of a potential new pipeline landfall and a potential new gas processing facility. Although the installation of pipelines has the potential to temporarily resuspend sediment in localized areas, this is expected to have a negligible impact. Depending on the sediment characteristics, sediment load, and duration of exposure, impacts to commercially valuable species within a sediment plume can vary. Responses range in severity from no effect to mortality, but mobile species can avoid severe effects by limiting exposure. Sessile organisms and those with limited mobility may be exposed for longer durations, leading to increasingly severe impacts (e.g., increased respiratory rates, reduced feeding, and mortality). Regulations, mitigations, and practices reduce the undesirable effects on coastal habitats from dredging and other construction activities; permit requirements should ensure that pipeline routes avoid sensitive coastal habitat types. At the expected level of impact, the resultant influence on fish resources would be short term and localized, affecting only small portions of fish populations and selected areas of EFH. As a result, there would be little disturbance to fish resources or EFH.

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. These activities are not only highly regulated but also localized and temporary in nature. The impacts to coastal water quality from routine activities associated with a CPA proposed action should be minimal because of the distance to shore of most routine activities and USEPA regulations that restrict discharges. Offshore water quality is affected temporarily and in a limited area by the discharge of produced water and the overboard discharge of drill muds. Maintenance dredging and canal widening in inshore areas causes only the temporary suspension of sediments. Negative impacts from most of these routine operations would require a short time for fish resources to recover. This is because of multiple life history and environmental factors such as fecundity or year-class recruitment through oceanographic circulation.

Offshore, many of the EFH's are protected under the stipulations and regulations currently in place. Without these measures, there could be major negative impacts to topographic features and live bottoms. However, with routine impact-producing factors mitigated by BOEM through the Topographic Feature Stipulation and the Live Bottom (Pinnacle Trend and Low Relief) Stipulations, negative impacts are expected to be avoided. These stipulations establish a No Activity Zone around BOEM-protected topographic features, such as the Flower Gardens Banks, and NTL 2009-G39 and NTL 2009-G40 advise operators of BOEM's distancing requirements for bottom disturbing activity from identified seafloor features (live bottoms, Pinnacles, topographic features, Potentially Sensitive Biologic Feature's, and features capable of supporting high-density deepwater benthic communities). Additionally, hard-substrate habitat provided by structure installation in areas where natural hard bottom is rare will tend to increase fish populations or attract fish populations. The removal of these structures will eliminate that habitat, except when decommissioned platforms are used as artificial reef material. This practice is expected to increase over time. A more detailed discussion of decommissioning and the impacts of these activities on marine fishes can be found in **Chapters 3.1.1.10 and 4.2.1.19** of this Supplemental EIS, respectively.

For these reasons, as well as the fact that Gulf of Mexico fish stocks have retained both diversity and relatively stable biomass throughout the years of offshore development and other disturbances, a CPA proposed action is expected to result in a minimal decrease in fish resources and/or standing stocks or in EFH.

Accidental disturbances resulting from a CPA proposed action, including oil or chemical spills and blowouts, have the potential to adversely affect fish resources and EFH within the CPA. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on fish resources and EFH can be found in Chapter 4.2.1.18.3 and Appendix D of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.18 of the WPA 233/CPA 231 Supplemental EIS.

If oil or chemical spills due to a CPA proposed action were to occur in open waters of the OCS proximate to mobile adult finfish, the effects would likely be nonfatal and the extent of damage would be reduced because adult fish have the ability to move away from a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. Weathered crude oil has been shown in laboratory experiments and field research to cause a range of sublethal effects including malformation, genetic damage, and physiological impairment in different life history stages of different fish species (Carls et al., 1999; Whitehead et al., 2011). Oil can be lethal to fish, especially in larval and egg stages, since early life stages of animals are usually more sensitive to environmental stress than adults (Moore and Dwyer, 1974). Therefore, fish populations would primarily be affected if oil reaches the coastal and estuarine areas because many species reside in estuaries for at least part of their life cycle or are dependent on the nutrients exported from the estuaries to the shelf region. However, pelagic species may also be affected. Offshore spawning and nursery habitat supports several valuable species that could likewise be impacted by widespread contamination of the epipelagic region. However, due to natural variability in spawning success, recruitment, oceanographic conditions, and other factors, it is difficult to attribute specific causes to short-term shifts in stocks and research to date has been inconclusive with respect to the individual contributions of the many factors impacting these fishes (Rijnsdorp et al., 2009; Atlantic Bluefin Tuna SRT, 2011; Rooker et al., 2013). The probability of a spill impacting these nursery habitats is low. Much of the coastal northern Gulf of Mexico is a moderate- to high-energy environment; therefore, sediment transport and tidal stratification should reduce the chances for oil persisting in these areas if they are oiled. The extent to which a spill could impact offshore spawning and nursery habitat is highly dependent upon the time of year of the event.

The effect of oil spills that may be associated with a CPA proposed action on fish resources is expected to cause a minimal decrease in standing stocks of any population because most spill events would be small in scale and localized. Historically, there have been no oil spills of any size in the Gulf of Mexico that have had a long-term impact on fishery populations. Although many potential effects of the *Deepwater Horizon* explosion, oil spill, and response have been alleged, the actual effects are largely unknown and likely to remain so for several years, until more research is completed and the analyses become available. Recent analysis of early stage survival of fish species inhabiting seagrass nursery habitat from Chandeleur Islands, Louisiana, to St. Joseph Bay, Florida, pre- and post-*Deepwater Horizon* oil spill show that immediate catastrophic losses of 2010 cohorts were largely avoided and that no shifts in species composition occurred following the spill (Fodrie and Heck, 2011). Analysis of the effects of a catastrophic oil spill can be found in **Appendix B**. The fish populations of the Gulf of Mexico have repeatedly proven to be resilient to large, annually occurring areas of anoxia, major hurricanes, and oil spills. Accidental events from a CPA proposed action are not expected to significantly affect fish populations or EFH in the Gulf of Mexico.

Summary and Conclusion

BOEM has reexamined the analysis for fish resources and EFH presented in the 2012-2017 WPA/CPA Multisale EIS and the WPA 233/CPA 231 Supplemental EIS, based on the additional information provided above. Various printed and Internet sources (including NMFS's databases, GMGFMC's website, EBSCO, Elsevier, PLoS ONE, and BioOne) were examined to assess recent information regarding this resource that may be pertinent to the CPA. No new significant information was discovered that would alter the impact conclusion for the fish resources and EFH presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

This cumulative analysis includes effects on fish resources and EFH's as a result of the OCS Program (a CPA proposed action and past and future OCS lease sales), State oil and gas activity, coastal development, commercial and recreational fishing, and natural phenomena. For a detailed analysis of the cumulative impacts to EFH, refer to Appendix D of the 2012-2017 WPA/CPA Multisale EIS. An example of impact-producing factors considered in this analysis include cumulative onshore impacts on EFH's, such as wetland loss as a result of human population expansion, as well as natural factors such as hurricane loss of wetlands, in addition to the cumulative impacts of OCS activities. Marine environmental degradation factors affecting water quality, such as hypoxia, are discussed in **Chapter 4.1.1.2**, and they are summarized here.

Healthy fishery stocks depend on EFH's, which are 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 (as described in Appendix D of the 2012-2017 WPA/CPA Multisale EIS) for marine species, a large portion of the GOM is designated as EFH. The cumulative effects of OCS oil- and gas- related and non-OCS oil- and gas-related factors on EFH's can be found in the respective resource chapters: water quality (**Chapter 4.1.1.2**); wetlands (**Chapter 4.1.1.4**); seagrass communities (**Chapter 4.1.1.5**); live bottom (pinnacle trend/low relief) (**Chapter 4.1.1.6**); topographic features (**Chapter 4.1.1.7**); *Sargassum* communities (**Chapter 4.1.1.8**); chemosynthetic deepwater benthic communities (**Chapter 4.1.1.9**); nonchemosynthetic deepwater benthic communities (**Chapter 4.1.1.10**); and soft bottom benthic communities (**Chapter 4.1.1.11**). The direct and/or indirect effects from cumulative OCS oil- and gas-related and non-OCS oil- and gas-related activities on fish resources are reanalyzed, while EFH's are summarized in this chapter.

OCS Oil- and Gas-Related Impacts

Infrastructure projections reflect long-term industry trends, and existing oil and gas infrastructure is expected to be sufficient to handle development associated with a CPA proposed action. Any expansion of existing facilities or construction of new facilities would be closely scrutinized by State and Federal permitting agencies to ensure that potential impacts to estuarine habitats are avoided or mitigated. Secondary factors, such as vessel traffic supporting ongoing operations, will continue to have the greatest probability of producing impacts to fish resources and EFH and should receive greater attention. 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, and marine traffic causes erosion of adjacent wetlands. These secondary impacts of canals to wetlands will continue. The incremental contribution of a CPA proposed action would be a small part of the cumulative impacts to wetlands, seagrass communities, and coastal water quality; however, with new technologies and continual regulation and monitoring by COE, these activities will cause fewer effects.

Pipeline installation would cause sediment resuspension. Depending on the sediment characteristics, sediment load, and duration of exposure, impacts to commercially valuable species within a sediment plume can vary. Responses range in severity from no effect to mortality, but mobile species can avoid severe effects by limiting exposure. Sessile organisms and those with limited mobility may be exposed for longer durations, leading to increasingly severe impacts (e.g., increased respiratory rates, reduced feeding, and mortality). However, OCS activities resulting in sediment suspension are temporary and localized, and because of regulations, permitting processes, and protective stipulations, the OCS activities are expected to have minimal impact on fish resources and EFH. BOEM has conservatively estimated that 0-1 new pipelines will make landfall in the Gulf of Mexico, and a total of 30,428-69,749 km (18,907-43,340 mi) of pipeline could be installed in the GOM during the 40-year analysis period (**Table 3-3**). Most oil and gas operations are assumed to use existing onshore structures and pipelines, which would have a small effect on coastal EFH and fish resources.

Topographic features in the GOM include the East and West Flower Garden Banks and Sonnier and Stetson Banks. The Topographic Features Stipulation, applied to appropriate leases and clarified in NTL 2009-G39, would prevent most of the potential impacts on topographic features from offshore oil and gas bottom-disturbing activities. Also, the guidance provided in NTL 2009-G40 would distance bottom-disturbing activities from deepwater benthic communities such as chemosynthetic communities and deepwater corals. The projected total number of production structure installations resulting from OCS oil- and gas-related activities in the CPA and GOM during the next 40 years and for all water depths is 1,180-1,640 (**Table 3-4**) and 1,435-2,026 (**Table 3-3**), respectively. Bottom disturbance from structure emplacement operations associated with a CPA proposed action would produce localized and temporary increases in suspended sediment loading. This would result in decreased water clarity and little reintroduction of pollutants. There is evidence that structure emplacements can act as fish-attracting devices and provide artificial habitat, resulting in the aggregation of migratory and reef fish species. It has also been reported that artificial habitat, such as that represented by some of the associated structures, can in some instances enhance production of fish (Stone et al., 1979; Carr and Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009).

It is estimated that 1,046-1,485 structures would be removed as a result of the OCS Program in the CPA during the next 40 years (**Table 3-4**) and that 1,279-1,837 structures would be removed as a result of the entire OCS Program during the next 40 years (**Table 3-3**). For more details on structure removal, please refer to *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf, Programmatic Environmental Assessment* (USDOI, MMS, 2005). The removal of structures results in the loss of artificial habitat that was temporarily available for the life of particular OCS oil- and gas-related activities, unless redeployed as artificial reef substrate. Redeployment of any structure as artificial reef substrate is contingent upon many factors, including operator interest and State and Federal approval of an application to participate in a State artificial reef program (**Chapter 3.3.3.5**). BOEM estimates that of the production structures removed in the next 40 years, 868-1,247 structures will be removed using explosives (**Table 3-3**). The potential for injury and mortality to fishes resulting from underwater blasts has been well documented (Hubbs and Rechnitzer, 1952; Ferguson, 1962; Teleki and Chamberlain, 1978; Govoni et al., 2008). Fish within the area of effect are subjected to a shock wave that expands radially, causing rapid contraction and over extension of the swim bladder, which may result in internal injury or mortality (Keevin and Hempen, 1997; Govoni et al., 2008). Invertebrates and fish with no swim bladder, or less well-developed swim bladders, are extremely resistant to underwater blasts. Other factors such as age, general health, water temperature, and reproductive condition may also influence mortality (Keevin and Hempen, 1997). It is expected that structure removals would have a major effect on fish resources near the removal sites. However, 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., 2001). The Topographic Features Stipulation (NTL 2009-G39) and the guidelines provided in NTL 2009-G40 would decrease impacts on benthic communities from bottom-disturbing activities such as anchoring and structure emplacement and removal.

Localized, minor degradation of coastal water quality is expected from a CPA proposed action within the immediate vicinity of the waterbodies proximate to the proposed service bases, commercial waste-disposal facilities, and gas processing facilities as a result of routine effluent discharges and runoff (**Chapter 4.1.1.2.1**). The degradation of water quality can cause increased physiological stress in marine organisms or can result in hypoxia, causing mobile species to avoid or leave low quality habitat. Because the input of effluent, runoff, and nutrients from a CPA proposed action is very limited, the incremental contribution of a CPA proposed action would be a very small part of the cumulative impacts to coastal water quality. A CPA proposed action would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes and sedimentation/sediment resuspension (**Chapter 4.1.1.2.2**). Offshore vessel traffic and OCS operations would contribute in a small way to regional degradation of offshore waters through different waste discharges and spills.

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. This is because offshore discharges of drilling mud dilute to near background levels within 1,000 m (3,280 ft) of the discharge point. Biomagnification of pollutants such as mercury are often associated with drilling discharges; however, the bioavailability of trace concentrations of mercury in discharged drilling mud has not been demonstrated. A recent study has concluded that platforms do not contribute to higher mercury levels in marine organisms (Sluis et al., 2013). Another study suggests that mercury in sediment from drilling platforms is not in a bioavailable form (Trefry et al., 2003). Because the deposition of drilling mud is limited in space around the platform and because the mercury contained in the mud is not in bioavailable form, the discharge of drilling mud around platforms is expected to have a negligible effect on fish at a population level.

Produced-water discharges contain components and properties potentially detrimental to fish resources. These include petroleum hydrocarbons, trace metals, radionuclides, and brine. Limited petroleum concentrations and metal contamination of sediments and the upper water column would occur out to several hundred meters or feet downcurrent from the discharge point. Because produced waters are limited in space and are quickly diluted, the effects of produced waters on fish populations in the OCS environment are expected to be small. Fish populations inhabiting offshore live bottoms would similarly not be impacted by produced waters because they are released and disperse near the surface and because the deposition of drilling mud is limited because of current mitigation. Offshore discharges and subsequent changes to marine water quality are also regulated by the U.S. Environmental Protection Agency's NPDES permits.

In the unlikely event of an offshore spill, the biological resources of hard/topographic features are expected to remain unharmed as the spilled substances would likely reach the seafloor in minute concentrations. These minute quantities may cause very short-term sublethal effects such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984). A more detailed analysis of the potential impacts to topographic features from an offshore spill can be found in **Chapter 4.1.1.7**.

Surface oil spills would have the greatest chance of impacting high-relief topographic features located in depths <20 m (65 ft; mostly sublethal impacts). A comprehensive survey of all low-relief live bottoms in the CPA has yet to be conducted, but all major topographic features are well described (Chapter 4.2.1.7.1 of the 2012-2017 WPA/CPA Multisale EIS). Only three high-relief features in the Gulf rise to water depths shallower than 20 m (65 ft). These are the East Flower Garden Bank (16 m; 52 ft), Stetson Bank (17 m; 55 ft), and Sonnier Bank (17 m; 55 ft).

Subsurface blowouts of both oil and natural gas wells and subsurface spills (pipeline spills) have the potential to adversely affect fishery resources and could cause localized, sublethal (short-term, physiological changes such as reduced feeding or increased respiration) impacts on the biologically sensitive underwater features, areas, and deepwater benthic communities. The range of potential impacts and most likely effects are discussed in the following chapters: live bottoms (Pinnacle Trend and low relief) (**Chapter 4.1.1.6**); topographic features (**Chapter 4.1.1.7**); chemosynthetic deepwater benthic communities (**Chapter 4.1.1.9**); nonchemosynthetic deepwater benthic communities (**Chapter 4.1.1.10**); and soft bottom benthic communities (**Chapter 4.1.1.11**). However, these events are rare and, should one occur, protective lease stipulations mitigate the potential impacts on the live bottoms of the entire activity area, so community-wide impacts should not occur. Sandy sediments resuspended as a result of a blowout would be quickly redeposited within 400 m (1,312 ft) of the blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters over a period of 30 days or longer. Effects on fish resources as a result of sediment resuspension due to a blowout, though longer in duration, would be similar to those described for other bottom-disturbing activities. These events are expected to have a negligible impact on fish populations.

Oil spills that contact coastal bays, estuaries, and offshore waters (each are EFH) when pelagic eggs and larvae are present have the greatest potential to affect fish resources. Early life stages of animals are usually more sensitive to environmental stress than adults (Moore and Dwyer, 1974), and oil can be lethal to fish, especially in larval and egg stages. Weathered crude oil has been shown in laboratory experiments to cause malformation, genetic damage, and even mortality at low levels in fish embryos of Pacific herring (Carls et al., 1998). However, the results of recent studies of fish resources (species and communities) indicate impacts resulting from the *Deepwater Horizon* oil spill have been largely indistinguishable from natural fluctuations or variability due to other anthropogenic activities (Atlantic Bluefin Tuna Status Review Team, 2011; Fodrie and Heck, 2011; Soniat et al., 2011; Carmichael et al., 2012; Moody et al., 2013; Rooker et al., 2013). Although there is a large body of information being developed through the NRDA process that is not yet available, these early results are not indicative of significant population-level responses. 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 sublethal 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.

Contamination from oil and hazardous substance spills should be primarily localized and not long term enough to preclude designated uses of the waters. For example, a large coastal spill that could occur from OCS oil- and gas-related activity in the CPA would likely originate near terminal locations, which are most numerous in the coastal zone of Louisiana (Figure 3-5 of the 2012-2017 Multisale EIS). As a result of spill response, containment, and recovery efforts, most of the inland spills' contents are expected to be recovered and what is not recovered would affect a small area and dissipate rapidly. The 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS analyzed the effect for oil spills ≥1,000 bbl if a spill was to occur due to a CPA proposed action. The probabilities of that spill contacting different EFH after 10 days and a spill (≥ 1,000 bbl) contacting an EFH after 30 days are presented in the following chapters of the 2012-2017 WPA/CPA Multisale EIS: water quality (Chapters 4.2.1.2.1.3 and 4.2.1.2.2.3); wetlands (Chapter 4.2.1.4.3); seagrass communities (Chapter 4.2.1.5.3); live bottoms (Chapters 4.2.1.6.1.3 and 4.2.1.6.2.3); topographic features (Chapter 4.2.1.7.3); *Sargassum* communities (Chapter 4.2.1.8.3); chemosynthetic deepwater benthic communities (Chapter 4.2.1.9.3); nonchemosynthetic deepwater benthic communities (Chapter 4.2.1.10.3); and soft bottom benthic communities (Chapters 4.2.1.11.3).

Loss of well control and resultant blowouts and pipeline spills seldom occur on the Gulf of Mexico OCS. Estimated occurrences and probabilities of these events for all water depths in the OCS are presented in Tables 3-19 and 3-20 of the 2012-2017 WPA/CPA Multisale EIS.

Subsurface blowouts, such as the *Deepwater Horizon* explosion, that include both oil and natural gas have the potential to affect fish populations, particularly eggs, larvae, and juveniles. The specific effects of this type of spill on individual fish populations in the GOM are currently being investigated. Few, if any, definitive results have been obtained at this time. Spills from this type of a blowout have a low probability of occurring. The cumulative impact on EFH and fish populations is, therefore, not anticipated to be large as a result of a CPA proposed action. For a more detailed analysis of low-probability catastrophic spills, refer to **Appendix B**.

Non-OCS Oil- and Gas-Related Impacts

Much of coastal wetland loss is a result of agricultural, commercial, and residential development; inshore oil and gas extraction; and river modification. The 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 because 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' human populations increase and with relative sea-level rise (GMFMC, 1998). Residential, commercial, and industrial developments are directly impacting EFH by dredging and filling coastal areas or by affecting the watersheds. Also, the conversion of wetland habitat into open water is projected to continue in the foreseeable future. This is actually a shift in EFH from important nursery habitat to open-water habitat. State oil and gas activities are projected to have greater and more frequent adverse impacts on wetlands than would the OCS Program offshore activities because of their proximity to the shore. Other factors that impact coastal wetlands include marsh burning and marsh-buggy traffic. 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. The Federal and State governments are also funding research and coastal restoration projects; however, it may take decades of monitoring to ascertain the long-term feasibility of these coastal restoration efforts.

Canal dredging primarily accommodates commercial, residential, and recreational development. Increased population and commercial pressures on the Gulf Coast are also causing the expansion of ports and marinas. Where new channels are dredged, wetlands would be adversely impacted by the channel, the disposal of dredged materials, and the development that it attracts. The continuing erosion of waterways maintained by COE is projected to adversely impact the productivity of wetlands along channel banks. Also, increased turbidity from dredging operations projected to continue within the coastal zone constitutes another considerable type of pollution. However, continual advances in technologies and mitigation required by COE in permits decrease many adverse effects on coastal habitats and water quality from dredging and related activities.

Estuarine water quality degradation is largely due to urban and agricultural runoff. The coastal waters of the CPA are expected to continue to experience nutrient enrichment, 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 will likely increase in numbers over the next 30-40 years based on impacts from the non-OCS oil- and gas-related impacts described above. The degradation of water quality is expected to continue due to contamination by point- and nonpoint-source discharges due to eutrophication of waterbodies, primarily due to runoff and hydrologic modifications. However, stringent water quality standards are monitored and enforced by USEPA and USCG. Municipal, agricultural, and industrial coastal discharges and land runoff would impact the health of marine waters. As the assimilative capacity of coastal waters is exceeded, there will be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of the designated uses of some shallow offshore waters due to hypoxia and red or brown tide impacts and to the levels of contaminants in some fish, thereby 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 Gulf area.

Commercial fishing activities that could impact topographic features 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 be potentially damaging to the bottom community as they drag. Trawls pulled over the bottom disrupt the communities that live on and just below the surface and also increase turbidity of the water (GMFMC, 1998).

Throughout the Gulf Coast, commercial trap fishing is used for the capture of reef fish, and commercial and recreational trap fishing is used for the capture of spiny lobster, stone crab, and blue crab. 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 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 destroyed by the placement and retrieval of traps in shallow environments (GMFMC, 1998).

Overfishing (commercial and recreational) has been determined to be a major factor in four populations of reef fish in the Gulf of Mexico. According to the NMFS Status of Stocks 2012 report, Gulf of Mexico overfished species included gag (*Mycteroperca microlepis*), greater amberjack (*Seriola dumerili*), red snapper (*Lutjanus campechanus*), and gray triggerfish (*Balistes capriscus*); all but red snapper were still subject to overfishing (USDOC, NMFS, 2013d). These species are reef fish that range throughout the Gulf and are discussed in Chapters 4.2.1.18.1 and 4.2.1.19.1 and Appendix D of the 2012-2017 WPA/CPA Multisale EIS and Chapters 4.1.1.16 and 4.1.1.17 of the WPA 233/CPA 231 Supplemental EIS. Many of the important species harvested from the Gulf of Mexico are believed to have been overfished, but managers are making progress in rebuilding or sustainably managing those stocks with known status (USDOC, NMFS, 2013d). However, there remain stocks with an unknown status and, while these represent a smaller fraction of commercial and recreational landings, it is possible that some are subject to overfishing and that continued fishing at the present levels may result in declines of fish resource populations and the eventual failure of certain fisheries. It is expected that overfishing of targeted species and trawl fishery bycatch will adversely affect fish resources. The impact of overfishing on fish resources is expected to cause a measurable decrease in populations, although the Gulf of Mexico Fisheries Management Council (GMFMC) has taken action to avoid the exploitation of overfished species in the form of increased regulations. The Magnuson-Stevens Fishery Conservation and Management Act and its amendments address sustainable fisheries and set guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities. Under this Act, fisheries management plans, including limits on catch and fishing seasons, are developed and proposed by the regional fisheries management councils for approval and implementation by NMFS. State agencies regulate inshore fishing seasons and limits.

Invasive species such as lionfish are a threat to commercially important species native to the Gulf of Mexico. Lionfish have been observed on natural bottom, reefs, and artificial structures across the northern Gulf of Mexico. These fish are voracious predators and have the potential to displace native species through competition for food sources and habitat space.

Finally, some natural phenomena can impact fish resources and EFH's. Nearshore habitat can be affected through events such as severe storms and floods. These events can accelerate wetland loss or damage oyster reef habitat. Offshore resources such as biologically sensitive underwater features may be damaged or buried by events like storms or turbidity flows, potentially affecting fish resources. Additionally, variability in spawning success and juvenile survival directly affect Gulf of Mexico fish populations. These natural phenomena are all continual, integral elements of the ecosystem, and impacts attributed to these events are often exacerbated by anthropogenic activities.

Summary and Conclusion

In summary, there are widespread anthropogenic and natural factors that impact EFH and fish populations in the Gulf of Mexico. Many State and Federal agencies have shared or sole responsibility for implementing the laws and regulations within their jurisdiction that ensure coastal development and industrial operations are performed responsibly and that potential impacts are avoided or properly mitigated. Despite this concerted effort, incremental, accidental and natural or unavoidable impacts occur. However, the forecasted activities associated with a proposed CPA action, planned, executed and mitigated in accordance with applicable regulations and guidelines, are expected to contribute minimally to the cumulative impact on fish resources and EFH.

As noted in **Chapter 4.1.1.18** of this Supplemental EIS, Chapter 4.2.1.18.1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.18 of the WPA 233/CPA 231 Supplemental EIS, most of the Gulf of Mexico is designated as EFH and encompasses many different types of habitats and resources, which are described in this Supplemental EIS. The extent of impacts from the *Deepwater Horizon* explosion, oil spill, and response to fish resources and EFH remains unclear at this time. This information is being developed through the NRDA process, data are still incoming and have not been made publicly available, and it is expected to be years before the information is available. No evidence of significant impacts to fisheries populations in the Gulf of Mexico have been shown to date.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources and scientific journals was conducted to determine the availability of recent information (including NMFS's databases, GMFMC's website, Science Direct, EBSCO, Elsevier, PLoS ONE, JSTOR, and BioOne). No new significant scientific information has been identified as relevant to this analysis since the publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

The severity and the duration of the effects of the *Deepwater Horizon* explosion, oil spill, and response on the fish assemblages and fisheries of the Gulf of Mexico are largely speculative at this time. No evidence of significant impacts to fish populations in the Gulf of Mexico have been shown to date. It is also difficult to gather reliable population information on all species, including highly migratory species, and to distinguish between population fluctuations due to the spill as opposed to other, naturally occurring environmental factors. Credible scientific information that is available on the impacts to the species has been applied using accepted methodologies. In any event, although some information is currently unavailable, it is not essential to a reasoned choice among alternatives for the reasons stated in this Supplemental EIS and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Nevertheless, information on the effects of the *Deepwater Horizon* explosion, oil spill, and response on fish resources and EFH is incomplete at this time and may take years to obtain and analyze. This information will be developed through the NRDA process, is not expected to be complete or released to the public for years, and will certainly not be available within the timeline contemplated in the NEPA analysis of this Supplemental EIS. Regardless of cost, it is not within BOEM's ability to obtain this information from the ongoing NRDA process. This information may be relevant to reasonably foreseeable significant impacts, and BOEM cannot definitively state at the present time whether this information may be essential to a reasoned choice among alternatives. BOEM's subject-matter experts, however, have used the scientifically credible information that is available and applied it using accepted scientific methodologies.

4.1.1.19. Commercial Fisheries

BOEM has reexamined the analysis for commercial fisheries presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for commercial fisheries presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts discussed in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of commercial fisheries and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.19 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.19 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

The potential routine impact-producing factors on commercial fisheries in the CPA are seismic surveys and operational noise, drilling, platform emplacement, platform removal, pipeline installation, waste discharge, channel dredging and oil spills. Analysis of the routine impacts of OCS activities associated with a CPA proposed action on commercial fisheries can be found in Chapter 4.2.1.19.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.19 of the WPA 233/CPA 231 Supplemental EIS.

Routine activities such as seismic surveys, platform operation, and vessel traffic produce noise of varying intensity and duration; a description of this factor can be found in **Chapter 3.1.1.2.1** of this Supplemental EIS, with a more detailed description provided in Chapters 3.1.1.2 and 3.1.1.6 of the 2012-2017 WPA/CPA Multisale EIS. A CPA proposed action, throughout the 40-year life cycle, is estimated to result in numerous seismic survey activities. Studies have shown that air guns can produce behavioral responses in fishes, possibly even resulting in species- or gear-specific effects on catch rate (Popper and Hastings, 2009; Fewtrell and McCauley, 2012; Lokkeborg et al., 2012). However, there is insufficient data to consistently predict that responses and important variables, such as the duration of exposure and repeated exposure, have not been fully addressed. Seismic surveys are cyclical, temporary, localized events, and they are not expected to have a significant impact on commercial fisheries.

Exploratory drilling rigs cause temporary interference to commercial fishing, lasting approximately 30-150 days, and emplaced structures represent a semipermanent obstruction to some forms of commercial fishing, trawling and longlining in particular. BOEM estimates that 31-60 platforms would be installed in waters 200 m (656 ft) or less in depth as the result of a CPA proposed action. At these depths, the structures would yield approximately 62-120 ha (310-600 ac) unavailable to trawling. Longline fishing is performed in water depths greater than 100 m (328 ft) and usually beyond 300 m (984 ft). BOEM estimates that 7-13 platforms will be installed in this depth range, presenting a minor space-use conflict. Concerns that an areal comparison insufficiently considers geological formations and other features that constitute "high-quality" fishing grounds are not justified since the stipulations and regulations currently in place protect these habitats from being impacted by OCS activities. In addition, the current paradigm posits these structures act as both fish-attracting and production-enhancing devices, depending upon the species (Carr and Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009). The resultant assemblages frequently include commercially valuable fishes, such as tunas (*Thunnus* spp.), red snapper (*Lutjanus campechanus*) and wahoo (*Acanthocybium solanderi*), and attract fishermen targeting these species. However, OCS platforms and supporting infrastructure do pose a hazard to commercial fishing vessels and gear. The Fishermen's Contingency Fund was created to compensate fishermen for economic and property losses as a result of oil and gas industry activities on the OCS (Sharp and Sumaila, 2009; USDOC, NMFS, 2013e). According to NMFS, claims were approved for $188,168 in FY 2010, $126,608 in FY 2011 and $63,588 in 2012.

The most commonly discharged offshore wastes are drilling mud and produced water. Drill mud contains metals such as mercury and cadmium, which are toxic to fishery resources, and produced water commonly contains brine, trace metals, hydrocarbons, organic acids, and radionuclides. Studies of drilling mud and produced-water discharges from platforms show that the plume disperses rapidly in both cases and does not pose a threat to commercial fisheries. Because of concern about bioaccumulation of mercury in some fishes (Oken et al., 2012), the Gulf of Mexico in general, and areas with OCS oil and gas infrastructure in particular, have been the subject of several studies on mercury concentrations in sediment and uptake of mercury associated with drilling. As of the writing of this document, the latest study to investigate potential relationships between mercury concentrations in fish tissues and habitat compared fish caught near platforms with those caught at non-platform habitat. The researchers found no significant difference in the total mercury concentrations in tissue samples taken from fish captured at either habitat type (Sluis et al., 2013). This study supports earlier research, which resulted in similar findings (Trefry et al., 2003; Lowery and Garrett, 2005).

Pipeline trenching, navigation channel dredging, and canal construction resuspend sediments, but they are expected to cause negligible impacts and would not deleteriously affect overall CPA commercial fishing activities. Depending on the sediment characteristics, sediment load, and duration of exposure, impacts to commercially valuable species within a sediment plume can vary. Responses range in severity from no effect to mortality, but mobile species can avoid severe effects by limiting exposure. Sessile organisms and those with limited mobility may be exposed for longer durations, leading to increasingly severe impacts (e.g., increased respiratory rates, reduced feeding, and mortality). Regulations, mitigations, and permit requirements should ensure that impacts to habitat are avoided or minimized. Platform emplacement would cause displacement of commercial fishing while operations are ongoing, and explosive removal of platforms will cause temporary displacement of commercial fishing activities and localized fish mortality. These effects are limited to a small percentage of the area fished and will not significantly impact commercial fishing or fish stocks in the CPA. Furthermore, some platforms will be decommissioned using nonexplosive methods and redeployed as artificial reef substrate. For more information, refer to **Chapter 3.3.3.5**.

Accidental disturbances resulting from a CPA proposed action, including oil spills and blowouts, have the potential to result in temporary closures and/or direct impacts to fish populations, both inshore and offshore, thereby affecting commercial fisheries within the CPA. Additional impact analysis of accidental events that may be associated with proposed CPA Lease Sales 235, 241, and 247 on commercial fisheries can be found in Chapter 4.2.1.19.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.19 of the WPA 233/CPA 231 Supplemental EIS.

In the event of an oil spill or blowout (refer to **Chapter 3.2.1 and Appendix B** for a detailed risk analysis), fish populations will primarily be impacted if the oil reaches the productive shelf and estuarine areas. Although there is a risk of spills occurring in coastal waters (0-5.6 km; 0-3.5 mi; 0-3.0 nmi), the majority of these would be small and unlikely to impact commercial fisheries. Most of these incidents would occur at or near pipeline terminals or shore bases and are expected to only temporarily affect a localized area. The probability of an offshore spill impacting these nearshore environments is low, and oil would generally be volatilized or dispersed by currents in the offshore environment. The most damaging oil spills to commercial fishery harvests would be those reaching the productive coastal waters or estuaries. However, while short-term negative impacts may be greatest on those populations that are short-lived and harvested annually, such as crabs and shrimp, or those populations that are sessile, such as oysters, these species have evolved to cope with high mortality through large population growth potential and should not suffer long-term population effects. Longer-lived species such as snapper and grouper have more resilience because these populations consist of multiple year classes that can breed, and the failure of any one year-class does not necessarily threaten the survival of the population. Historically, spills of sufficient magnitude to potentially and broadly affect these sensitive areas have a very low probability of occurrence.

Fisheries closures may result from a large spill event. When closures occur, they are generally small and short lived. Most fishermen should be able to avoid these closures, causing only localized economic impacts. Large-scale closures are rare, but can inflict more widespread negative economic impacts on commercial fishermen due to inability to fish and decreased marketability of their catch. These closures may also relieve fishing pressure and allow fisheries populations to increase the following year.

The potential impacts due to accidental events (i.e., a well blowout or an oil spill) from a CPA proposed action are anticipated to be minimal. The most typical events are small and of short duration, and the effects are so localized that fish may avoid the area adversely impacted.

Summary and Conclusion

The activities associated with a CPA proposed action would cause short-term, localized disturbances to fishes in the vicinity (e.g., acoustic surveys and resuspension of sediments) or highly localized fish mortality (e.g., explosive severance activities). However, these impacts do not extend to population-level effects due to the limited spatial and temporal nature of routine activities. Although structure emplacement represents a long-term, space-use conflict, the area excluded is insignificant in comparison with the area available for some commercial fishers. Furthermore, historical landings data do not support an argument for regional negative impacts to commercial fisheries through either stock reduction or access limitations. While accidental disturbances have the potential to result in broader impacts to commercial fisheries through closures or juvenile mortality, these are very low-probability events.

In conclusion, impacts to commercial fisheries due to routine activities or accidental events resulting from a CPA proposed action are expected to be minimal. No new information was discovered that would alter the conclusion for commercial fisheries presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

Cumulative Impacts

Background/Introduction

This cumulative analysis considers activities that have occurred, are currently occurring, and could occur and adversely affect commercial fishing for the years 2012-2051. These activities include the effects of the OCS Program (proposed action and prior and future OCS sales), State oil and gas activity, oil transport by tankers, natural phenomena, and commercial and recreational fishing.

The potential impact-producing factors considered in the cumulative analysis include seismic surveys and operational noise, drilling, platform emplacement, platform removal, pipeline installation, waste discharge, channel dredging, oil spills, State oil and gas activity, coastal commercial and residential development, commercial and recreational fishing techniques and practices, and natural phenomena.

OCS Oil- and Gas-Related Impacts

Seismic surveys are used in both shallow- and deepwater areas of the Gulf of Mexico. Seismic surveys and operational noise have been shown to produce behavioral responses in fishes, but the results of studies are inconclusive and specific behaviors or effects on catch rate cannot be predicted. Furthermore, there is evidence that repeated episodes may elicit reduced or different responses from fish (Fewtrell and McCauley, 2012). Seismic surveys also cause space-use conflicts but are limited in time and space. Although fishermen may be precluded from an area for several days, this should not significantly affect the annual landings or the value of landings for commercial fisheries. Targeted species are usually found in many adjacent locations, and commercial fishermen typically do not fish only one locale.

Production facilities also compete with commercial fishing interests for physical space in the open ocean, and associated underwater OCS obstructions can pose hazards to fishing gear. BOEM estimates there will be 1,180-1,640 production structures installed in the CPA over the next 40 years (**Table 3-4**). Each production platform excludes a small area from the resources available for most commercial fishing. However, even the cumulative impact of these exclusions is small in comparison to the total area available for commercial fishing in the CPA. Concerns that an areal comparison insufficiently considers geological formations and other features that constitute "high-quality" fishing grounds are not justified since the stipulations and regulations currently in place protect these habitats from being impacted by OCS activities. In addition, the current paradigm posits these structures act as both fish-attracting and production-enhancing devices, depending upon the species (Carr and Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009). As such, it is expected that these benefits, over the 40-year analysis period, will outweigh localized disturbances and fish mortality resulting from exploration, installation, and decommissioning activities. The impact of a CPA proposed action on commercial fisheries is anticipated to be small.

Offsetting the projected installation of facilities is the removal of existing platforms that have reached the end of their useful life. Approximately 1,046-1,485 production structures are expected to be removed from the CPA over the next 40 years (**Table 3-4**). Although each removal frees an area for commercial fishing, it also removes artificial hard substrate. Since BSEE encourages the reuse of obsolete oil and gas structures as artificial reefs, a lessee may be granted a departure from the requirement to remove a platform if the necessary conditions are met (BSEE Interim Policy Document 2013-07). In these instances, decommissioned structures may be used in State-managed Rigs-to-Reefs programs, and accepted structures would continue to serve as artificial reef substrate. It is estimated that 60 percent of the projected removals will involve explosive severance activities. These removal operations result in localized mortality of fishes. A study of explosive removals found that associated mortality for three commercially important fishes did not significantly alter projected stocks (Gitschlag et al., 2000). To account for inherent variations in species composition and abundance among platforms (e.g., Stanley and Wilson, 1997; Gitschlag et al., 2000; Stanley and Wilson, 2000; Wilson et al., 2003), mortality estimates were doubled and stock estimates were recalculated. Although Gitschlag et al. (2000) was limited and cannot be directly applied to all species or habitats, it is reasonable to assume that other commercially important fishes would respond similarly. At the projected rate of removal, these activities are not expected to have a substantial negative impact on stocks of commercially important fishes.

Pipeline trenching, dredging, and canal construction activities resuspend sediments. Depending on the sediment characteristics, sediment load, and duration of exposure, impacts to commercially valuable species within a sediment plume can vary. Responses range in severity from no effect to mortality, but mobile species can avoid severe effects by limiting exposure. Sessile organisms and those with limited mobility may be exposed for longer durations, leading to increasingly severe impacts (e.g., increased respiratory rates, reduced feeding, and mortality). However, sandy sediments are quickly redeposited within 400 m (1,312 ft) of a trench, and finer sediments are widely dispersed and redeposited over a period of hours to days within a few thousand meters of the event. No significant effects to commercial fisheries are anticipated as a result of pipeline trenching because these are localized, temporary events. The cumulative effect on commercial fisheries from pipeline trenching is not expected to be distinguishable from natural events or natural population variations.

Drilling mud discharges contain chemicals toxic to marine fishes that include brine, hydrocarbons, radionuclides, and metals. One of the main concerns of the concentrations of metals in the drilling muds is that mercury can be magnified in the food chain. Because of concern about bioaccumulation of mercury in some fishes (Oken et al., 2012), the Gulf of Mexico in general, and areas with OCS oil and gas infrastructure in particular, have been the subject of several studies on mercury concentrations in sediment and uptake of mercury associated with drilling. Recent studies have concluded that platforms do not contribute to higher mercury levels in marine organisms (Sluis et al., 2013). Offshore discharges of drilling mud have been shown to dilute to near background levels within 1,000 m (3,281 ft) of the discharge point and would not cause a concentration of mercury in the food chain. These discharges would therefore have a negligible cumulative effect on fisheries because of the dilution of the metal to background levels before it enters the food chain. Produced-water discharges (Chapter 3.1.1.4.2 of the 2012-2017 WPA/CPA Multisale EIS) contain components and properties potentially detrimental to commercial fishery resources. However, offshore discharges of produced water also disperse and dilute to near background levels within 1,000 m (3,281 ft) of the discharge point and have a negligible cumulative effect on fisheries. No mortality has been attributed to produced-water discharges, and no consensus of sublethal effects to fish has been reported in the literature. Offshore discharges and subsequent changes to marine water quality are closely regulated by the U.S. Environmental Protection Agency's NPDES permits. The input of drilling mud and produced waters are limited and are diluted very quickly in the marine environment. Their environmental effects are, therefore, expected to be limited.

Loss of well control and resultant blowouts in the Gulf OCS are uncommon and, since 1970, there have been only 13 losses of well control that have resulted in >50 bbl of oil being spilled. Oil spills, including catastrophic subsurface blowouts that include both oil and natural gas, have the potential to affect fish populations, in particular eggs and larvae. However, the probability of an offshore spill impacting these nearshore environments is low, and oil would generally be volatilized or dispersed by currents in the offshore environment. The most damaging oil spills to commercial fisheries harvests would be those reaching the productive waters of the continental shelf or estuaries. However, while short-term negative impacts may be greatest on those populations that are short-lived and harvested annually, such as crabs and shrimp, or those populations that are sessile, such as oysters, these species have evolved to cope with high mortality through large population growth potential and should not suffer long-term population effects. Longer-lived species such as snapper and grouper have more resilience because these populations consist of multiple year-classes that can breed, and the failure of any one year-class does not necessarily threaten the survival of the population. Historically, spills of sufficient magnitude to potentially and broadly affect these sensitive areas have a very low probability of occurrence. Furthermore, potential population losses may be somewhat offset by commercial fisheries closure areas necessitated by a large spill.

The full effects of catastrophic subsurface blowouts, such as the *Deepwater Horizon* explosion, on individual fisheries in the Gulf of Mexico are currently unknown, but spills of this type are a low-probability event. This type of spill is not expected to occur with a CPA proposed action. However, in the unlikely event a spill of that extent does occur, the potential impacts are discussed in **Appendix B**.

Non-OCS Oil- and Gas-Related Impacts

There is competition among large numbers of commercial fishermen, commercial operations employing different fishing methods, and commercial and recreational fishermen for a given fishery resource. The effects of overfishing of finfish resources are discussed in **Chapter 4.1.1.19** of this Supplemental EIS and Chapter 4.2.1.19 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. When practiced nonselectively, fishing techniques such as trawling, gill netting, or purse seining may reduce the standing stocks of the desired target species. This can also significantly affect species other than the target. For example, bycatch of the commercial shrimping industry is believed to have been a significant factor in the population decline of red snapper. In addition, continued fishing of most commercial species at the present levels can result in rapid declines in the landings and the eventual failure of certain fisheries if not actively managed.

Space-use conflicts and conflicts over possession of the resources can result from different forms of commercial operations and can occur between commercial and recreational fisheries. These effects have resulted in State and Federal constraints such as weekday fishing only, quotas, and/or gear restrictions on commercial fishing activity. The Magnuson-Stevens Fishery Conservation and Management Act and its amendments address sustainable fisheries and set guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities. Under this Act, fisheries management plans, including limits on catch and fishing seasons, are developed and proposed by the regional fisheries management councils for approval and implementation by NMFS. State agencies regulate inshore fishing seasons and limits. Another important consideration is the variability in fish populations, which fluctuate in numbers from year to year due to natural factors such as spawning success and juvenile survival.

The size of non-OCS oil- and gas-related or coastal spills is expected to be small and to cause a minimal decrease in commercial fishing activity local to the spill area. Because these spills are small, the resultant influence on commercial fishing, landings, or the value of those landings is not expected to be distinguishable from that of natural population variations.

The most serious impact on commercial fisheries is the cumulative loss of wetlands. Wetland loss as a result of commercial and residential development is one of the major factors in this trend, although this is regulated and mitigated by COE. Wetland conversion to open water results in a permanent loss of nursery and foraging habitat for many commercial fish stocks. The loss of wetlands also contributes to the intrusion of saltwater into oyster-producing waters, resulting in increased disease and predation. Resource management agencies, both State and Federal, set restrictions and issue permits in an effort to mitigate the effects of development projects and industry activities. The Federal and State governments are also funding research and coastal restoration projects; however, it may take decades of monitoring to ascertain the long-term feasibility of these coastal restoration efforts. In comparison to the large area of wetland loss due to commercial and recreational development (such as marinas and camps) as well as to natural forces such as hurricanes, any incremental wetland loss due to a CPA proposed action is expected to be minor. A detailed discussion of the impacts to wetlands due to commercial and recreational development can be found in Chapter 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in the WPA 233/CPA 231 Supplemental EIS.

Hurricanes may impact commercial fishing by damaging gear and shore facilities, and by dispersing resources over a wide geographic area. Hurricanes may also affect the availability and price of key supplies and services (e.g., fuel), therefore affecting commercial fishing. Hurricanes suspend fishing activity and are destructive to wetlands that are nursery grounds to many commercial fish. Hurricanes can be extremely destructive to oyster beds by causing siltation over the beds and smothering spat along with adult oysters as evidenced by Hurricanes Katrina, Rita, Gustav, and Ike. 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. Equally as destructive were Hurricanes Gustav and Ike in 2008. These impacts to commercial fisheries from the hurricanes were so severe that Commerce Secretary Gutierrez determined a fisheries resource disaster as a result (Upton, 2010). However, natural disaster impacts such as these are easily distinguished from incremental impacts of OCS activities.

Other phenomena that could impact commercial fisheries include hypoxia events and red and brown tides. Hypoxia events can kill or displace different species, such as brown shrimp, so they are more difficult to catch in known fishing grounds. Red and brown tides can close areas to fishing. A CPA proposed action is expected to have minimal additive adverse impacts on commercial fisheries when combined with other anthropogenic and natural disturbances.

Summary and Conclusion

Activities resulting from the OCS oil- and gas-related and non-OCS oil- and gas-related events have the potential to cause limited detrimental effects to commercial fishing, landings, and the value of those landings. The impact-producing factors of the cumulative scenario are the installation of production platforms and underwater OCS obstructions, production platform removals, seismic surveys and operational noise, petroleum spills, subsurface blowouts, pipeline trenching, offshore discharges of drilling mud and produced waters, commercial and recreational fishing techniques or practices (overfishing), wetland loss, hurricanes, and other phenomena.

The installation of each production platform excludes a small area from the resources available for most commercial fishing. However, even the cumulative impact of these exclusions is small in comparison to the total area available for commercial fishing in the CPA. Concerns that the areal comparison insufficiently considers geological formations and other features that constitute "high-quality" fishing grounds are not justified since the stipulations and regulations currently in place protect these habitats from being impacted by OCS activities. Furthermore, the addition of OCS structures potentially enhances production for some commercially valuable species (Stone et al., 1979; Carr and

Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009). It is expected that these benefits, over the 40-year analysis period, will outweigh the localized disturbances and fish mortality resulting from exploration, installation, and decommissioning activities. Because the impacts from platform removals are so localized, the cumulative impact of these activities to commercial fisheries is anticipated to be minor. The effects of seismic surveys have been determined to be limited in time and space. The effects of seismic surveys are, therefore, expected to be minimal overall.

Subsurface blowouts, such as the *Deepwater Horizon* explosion that include both oil and natural gas, have the potential to affect fish populations, particularly eggs and larvae. The potential impacts are discussed in **Appendix B**. Because spills of this magnitude are low-probability events, their contribution to the cumulative impact on commercial fisheries populations is not expected to be large as a result of a CPA proposed action.

Significant contributions to cumulative impacts from OCS oil- and gas-related and non-OCS oil- and gas-related activities are not anticipated as a result of pipeline trenching because sandy sediments are quickly redeposited within 400 m (1,312 ft) of a trench and because finer sediments are widely dispersed and redeposited over a period of hours to days within a few thousand meters of the event. These are small areas as compared with the rest of the Gulf of Mexico, and they are temporary disturbances.

Offshore discharges of drilling mud have been shown to dilute to near background levels within 1,000 m (3,281 ft) of the discharge point. The mercury in sediments near drilling platforms is not in a bioavailable form. For these reasons stated here and in the section above, the contribution of drilling discharge and produced-water discharge to the cumulative impacts of a CPA proposed action is not anticipated to be significant.

Overfishing (including bycatch) has contributed to the decline of some populations of commercial fish species in the Gulf of Mexico. It is the responsibility of the regional fisheries management councils and NMFS to propose, implement, and enforce guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities.

Overall, of the many anthropogenic and natural factors impacting fish resources in the Gulf of Mexico, those stemming directly from OCS oil- and gas-related activities are federally regulated or mitigated, and are small. Commercial fish and shellfish populations have remained relatively healthy in the Gulf of Mexico in spite of ongoing anthropogenic and natural disturbances. Compared with non-OCS oil- and gas-related activities, the incremental effect of a CPA proposed action is not expected to be significant.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A thorough search of information sources, including Internet research databases (EBSCO, PLoS ONE, JSTOR, Elsevier, and BioOne), coastal universities, and State and Federal environmental agencies, was conducted to determine the availability of new pertinent scientific information since the publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Information relevant to this analysis is summarized below.

Two separate studies investigating potential impacts from the *Deepwater Horizon* oil spill on eastern oysters (C*rassostrea virginica*) were recently published. In the first, oysters that were transplanted before, during, and after the *Deepwater Horizon* oil spill, in areas of Mobile Bay and the Mississippi and Alabama coast that were potentially exposed to oil, did not show evidence of oil-derived C and N in their shells or tissue (Carmichael et al., 2012). This finding indicates that the oysters sampled were either not exposed to oil, did not feed on oiled food sources, or consumed too little oiled food to detect in their shells and tissue. It is also possible that the oysters rapidly depurated any consumed oil or slowed filter feeding due to the stress of oil exposure. Whatever the reason, because oysters did not assimilate oil-derived C and N, they did not provide a contaminated food source to higher trophic levels (Carmichael et al., 2012). In the second study, oysters collected from oil exposed areas of Mississippi Sound 6 months after the *Macondo* well was capped did not show PAH accumulation (Soniat et al., 2011). Although the study was limited, the observed oyster condition, infection rate, and reproductive state were within expected ranges for oysters sampled at the salinities recorded, but not exposed to oil. Both oyster studies caution, however, that sample sizes were small and the findings of the study should not be extrapolated to all oysters in the GOM.

The NMFS has released its annual update to its Fisheries Economics of the U.S. report (USDOC, NMFS, 2012). This report provides a variety of information regarding the economic significance of commercial fishing activity in the Nation, by region and state. **Table 4-2** presents data from this report on each State's landings revenue, sales impacts, job impacts, and commercial fishing location quotient (CFLQ). In 2011, landings revenue in all Gulf Coast States except Mississippi was higher than in any year from 2002 through 2010. Landings revenue in Mississippi was higher in 2011 than in 2010 but still lower than levels that prevailed in prior years; this is largely because Gulf menhaden (*Brevoortia patronus*) prices in Mississippi fell from 0.08 cents per pound in 2009 and 2010 to 0.04 cents per pound in 2011. While Louisiana had the highest landings revenue, Florida had the largest amount of sales and job impacts due its large seafood processing industry. The final column in **Table 4-2** presents each state's CFLQ, which is a measure of the scale of the seafood industry in each state relative to that state's total economy. Louisiana has the highest CFLQ in the Gulf (1.58), which means that the seafood industry is 1.58 times as large in Louisiana as in the average U.S. state.

The NMFS reports each year to the Congress and Fishery Management Councils on the status of all fish stocks in the Nation. As of the 2012 status report (USDOC, NMFS, 2013d), overfished species in the Gulf of Mexico are red snapper, greater amberjack (*Seriola dumerili*), gag grouper (*Mycteroperca microlepis*), and gray triggerfish (*Balistes capriscus*). Although the report has been updated, there have been no changes in the species considered overfished in the Gulf of Mexico. Annual landings data may be obtained from NMFS's website (USDOC, NMFS, 2014b). These data are updated regularly, but delays in submission and processing may lead to data discrepancies between extracts over a period of months or years; refer to the website for the most up-to-date commercial fisheries information. Annual landings are subject to a wide array of factors that result in fluctuations from year to year. Many State and Federal agencies have shared or sole responsibility for implementing the laws and regulations within their jurisdiction, ensuring that coastal development and industrial operations are performed responsibly and that potential impacts are avoided or properly mitigated. The Magnuson-Stevens Fishery Conservation and Management Act and its amendments address sustainable fisheries and set guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities. Under this Act, fisheries management plans, including limits on catch and fishing seasons, are developed and proposed by the regional fisheries management councils for approval and implementation by NMFS. State agencies regulate inshore fishing seasons and limits. Furthermore, natural variability in spawning success and recruitment affect populations, and severe weather events and persistent changes in environmental conditions may also elicit species-specific responses that impact fishing success in any given year.

In 2012, Gulf menhaden constituted the largest Gulf fishery, by weight, although landings were at the lowest level since 2006. White shrimp (*Litopenaeus setiferus*) catch was at its highest since 2009, but brown shrimp (*Farfantepenaeus aztecus*) production in the Gulf was down from 2011. Blue crab (*Callinectes sapidus*) harvest was down slightly from 2011, but the value increased. The eastern oyster harvest was the highest since 2009 and the total value of the harvest was the highest in the past 10 years. Red snapper landings have increased for the past 5 years, but it is worth noting that quota increases have also occurred in each of the past 4 years (GMFMC, 2013).

As discussed in Chapter 4.2.1.19 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, BOEM has identified incomplete information regarding impacts of the *Deepwater Horizon* explosion, oil spill, and response to commercial fish species in the CPA. This information cannot be obtained because the overall costs are exorbitant. This incomplete information may be relevant to evaluating adverse effects because the full extent of potential impacts on commercially valuable species and commercial harvests are not known. BOEM used existing information and reasonably accepted scientific methodologies to extrapolate from available information in completing the relevant analysis, such as studies investigating the evidence of oil and impacts stemming from exposure to oil in oysters, and NMFS stock assessments and reports. None of these sources reveal reasonably foreseeable significant adverse impacts. For example, studies of oysters from areas known or suspected to have been exposed to oil have not found evidence of significant adverse impacts, and the organizations responsible for fisheries management have not reported stock or harvest fluctuations outside the range of historical variation for commercially important species such as brown shrimp and Gulf menhaden. Although the body of available information is incomplete and long-term effects cannot yet be known, the evidence currently available supports past analyses and does not indicate severe adverse impacts to commercial fisheries. Therefore, BOEM has determined that the information is not essential to a reasoned choice among alternatives.

4.1.1.20. Recreational Fishing

BOEM has reexamined the analysis for recreational fishing presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for recreational fishing presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analyses and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of recreational fishing and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.20 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.20 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since the publication of these documents is presented below.

Impacts of Routine and Accidental Events

A detailed analysis of the routine impacts of proposed CPA Lease Sales 235, 241, and 247 on recreational fishing can be found in Chapter 4.2.1.20 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.20 of the WPA 233/CPA 231 Supplemental EIS.

Activities during the initial phases of a CPA proposed action, such as seismic surveying operations and other forms of vessel traffic, may lead to some space-use conflicts with recreational fishermen. Vessel traffic during subsequent infrastructure emplacement, structure installation, and production operations could also lead to some space-use conflicts with recreational fishing activities. The OCS oil- and gas-related activities could also affect the aesthetics of fishing in a particular location, which could dissuade anglers from fishing in specific locations. Proposed CPA Lease Sales 235, 241, and 247 may also lead to low-level environmental degradation of fish habitat (**Chapter 4.1.1.18**), which would negatively impact recreational fishing activity. However, these minor negative effects would likely be outweighed by the beneficial addition of hard substrate and complex habitat provided by oil and gas infrastructure. The level of participation in any particular State Rigs-to-Reefs program will be an important determinant of the long-term impact of a CPA proposed action on recreational fishing activity. As structures are scheduled for decommissioning, a higher level of participation may benefit fishermen through the retention of complex habitat and potentially enhanced production for some recreationally desirable species, as opposed to structure removals (particularly those that use explosives) that can negatively impact the recreational activity that depends on any particular platform.

A detailed analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on recreational fishing can be found in Chapter 4.2.1.20 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.20 of the WPA 233/CPA 231 Supplemental EIS.

Oil spills can arise from accidents with respect to vessels, pipelines, drilling operations, or production operations. An oil spill would likely lead to recreational fishing closures in the vicinity of the oil spill. Small-scale spills should not affect recreational fishing to a large degree due to the likely availability of substitute fishing sites in neighboring regions. The longer-term effects of an oil spill will be determined by its effects on fish populations (**Chapter 4.1.1.18**), as well as by its effects on people and firms that support recreational fishing activity. The impacts of low-probability catastrophic oil spills are described in **Appendix B**.

Summary and Conclusion

BOEM has reexamined the analysis for recreational fishing presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for recreational fishing presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231

Supplemental EIS because the new information was consistent with prior expectations. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The cumulative impacts to recreational fishing activity will arise from a CPA proposed action, the existing OCS Program, and the expected progression of the recreational fishing industry in the Gulf of Mexico. These impacts would arise from the cumulative effects on fish resources in the Gulf of Mexico, which are discussed in **Chapter 4.1.1.18**. Because many of the recreationally sought fishes are also harvested commercially, a number of the cumulative impacts to the recreational fishing industry are similar to those of the commercial fishing industry (**Chapter 4.1.1.19**). This is true even though recreational fishing is primarily confined to smaller, closer inshore areas of the Gulf of Mexico than commercial fishing. The cumulative impacts unique to recreational fishing activity are discussed below.

OCS Oil- and Gas-Related Impacts

Routine OCS Processes

The impacts of production platforms, underwater obstructions, seismic surveys, pipeline trenching, and discharges of drilling mud and produced waters on commercial fishing activity are discussed in **Chapter 4.1.1.19**. The impacts of these factors will be similar for recreational fishing activity to a large extent. In particular, these routine processes can cause space-use conflicts and can impact the habitats of certain fish species. The main difference is that recreational fishing activity generally occurs closer to shore than commercial fishing; therefore, these impacts will occur for recreational fishing activity mainly if these activities occur close to shore. Recreational fishing activity could also be negatively impacted if the aforementioned activities temporarily negatively affect the aesthetics of fishing in nearby areas. For example, the visual impacts or the noise impacts from OCS oil- and gas-related activities and structures could dissuade anglers from fishing in a certain location. However, in most instances, there would likely be a number of suitable substitute recreational fishing sites if any temporary disruptions arose due to OCS oil- and gas-related activities.

Oil Spills

A CPA proposed action would contribute to the risk of an oil spill arising from the broader OCS Program. An oil spill would likely lead to recreational fishing closures in the vicinity of the oil spill. Small-scale spills should not affect recreational fishing to a large degree due to the likely availability of substitute fishing sites in neighboring regions. The longer-term effects of an oil spill will be determined by its effects on fish populations (**Chapter 4.1.1.18**). The impacts of a low-probability catastrophic oil spill are discussed in **Appendix B**.

Artificial Reef Development and Structure Removals

Proposed CPA Lease Sales 235, 241, and 247 are expected to result in oil and gas development, and the semipermanent addition of artificial substrate in the form of platforms and supporting infrastructure. These structures incidentally serve as artificial reefs for the duration of their life cycle, providing habitat for some epifauna and associated fish communities. The extent to which a platform will support recreational fishing activity is dependent on fish species in the area and accessibility to recreational fishermen.

Since oil/gas platforms are hypothesized to attract and/or support a large fish population, the effects of OCS oil- and gas-related actions become particularly important during the decommissioning stage of an oil platform's life cycle. Namely, the removal of a platform from a particular site has the potential to damage the fish assemblages associated with that structure. This in turn will also affect recreational fishing activity in a particular area. Gitschlag et al. (2000) conducted an analysis of the impacts to fish populations from the use of explosives to remove decommissioned oil platforms. They found that species such as red snapper and sheepshead are particularly vulnerable to the use of explosives; however, they also reported that the scale of these impacts relative to the stock of these species were relatively small at the sites that were included in the study.

As an alternative to removing an oil platform, the owner of an oil platform has the option to apply for participation in the Rigs-to-Reefs program of the appropriate state. These programs allow for portions of oil platforms to remain in the water as reefs after the productive life of a platform has ended. Platforms that are a part of these programs are either toppled in place or are moved to a location that is a suitable fish habitat. The U.S. policy towards artificial reef creation is outlined in the *National Artificial Reef Plan: Guidelines for Siting, Construction, Development, and Assessment of Artificial Reefs* (USDOC, NOAA, 2007). The BSEE policy regarding Rigs-to-Reefs programs is outlined in *Rigs-to-Reefs Policy, Progress, and Perspective* (Dauterive, 2000) and was updated in *Rigs to Reefs Policy Addendum: Enhanced Reviewing and Approval Guidelines in Response to the Post-Hurricane Katrina Regulatory Environment* (USDOI, MMS, 2009c) in light of Hurricane Katrina. Hiett and Milon (2002) present estimates of the scale of recreational fishing activity near oil and gas structures. This study found that 20 percent of private boat fishing, 32 percent of charter boat fishing, 51 percent of party boat fishing, and 94 percent of diving activities in Texas, Louisiana, Mississippi, and Alabama occur near oil and gas structures.

Deepwater Horizon *Explosion, Oil Spill, and Response*

The *Deepwater Horizon* explosion, oil spill, and response may make recreational fishing activity in the GOM more sensitive to additional oil spills that may occur. This is because the fish populations in the Gulf of Mexico are still responding to the spill, the ultimate outcome of which is not yet clear (**Chapter 4.1.1.18)**. The particular sensitivity of recreational fishing to the *Deepwater Horizon* explosion, oil spill, and response is also due to the complex manner in which recreational fishing activity and tourism interact. Namely, recreational fishing activity is one of a number of factors that draw tourists to a particular region. The high level of national attention focused on the *Deepwater Horizon* explosion, oil spill, and response suggests that future oil spills, even if smaller in scale, could raise greater concerns regarding recreational fishing in affected areas among tourists. While this effect may be offset by additional fishing by others, any decrease in fishing-based tourism could have broader impacts to a local economy.

Non-OCS Oil- and Gas-Related Impacts

State and Federal Fisheries Management Plans

State and Federal Fisheries Management Plans determine the manner in which recreational fishing activities can occur in any particular area. Recreational fishing activity is highly regulated, primarily to ensure a sustainable fisheries population through time. This often takes the form of catch limits per trip and quotas for overall catch per species during a given season. Recreational fishing activity in Federal waters is governed by the Gulf of Mexico Fishery Management Council (GMFMC). Each State has its own guidelines for recreational fishing in State waters. Fisheries Management Plans could serve to mitigate the effects of an oil spill since these plans are often designed to maintain stable fishing activity. For example, the GMFMC allowed for a supplemental red snapper season in October 2010 since red snapper catch was unusually low during the *Deepwater Horizon* explosion, oil spill, and response (GMFMC, 2010). This supplemental red snapper season was designed to allow the 2010 quota for red snapper catch to be reached.

Hurricanes

The impacts of a CPA proposed action on recreational fishing should be viewed in light of the ongoing risk of hurricanes in the Gulf of Mexico. Hurricanes cause short-term disruptions to recreational fishing activity in the immediate geographic area. Recreational fishing activity is also vulnerable to the disruptions in overall tourism activity that would arise in light of a hurricane. Finally, hurricanes can degrade the wetland areas that play important roles in fish ecosystems (**Chapter 4.1.1.4**).

Economic Factors

The level of recreational fishing activity is dependent on various economic factors. Recreational fishing activity will likely positively correlate to overall economic conditions. This is both due to the costs of recreational fishing activity and to the tendency of consumers to direct lower levels of spending towards leisure activities during a recession. Recreational fishing activity should also correlate with broader tourism trends in particular areas. In addition, recreational fishing activity will likely correlate with trends in input costs, particularly fuel prices. Finally, recreational fishing activity is fairly seasonal, often peaking during summer months. The NMFS provides angler effort data in 2-month increments. In 2012, the percentage of overall angler effort that occurred in each 2-month period in Louisiana, Mississippi, Alabama, and West Florida combined were as follows: January/February (13.0%); March/April (16.4%); May/June (22.0%); July/August (21.6%); September/October (15.4%); and November/December (11.7%).

State Oil and Gas Activities

State oil and gas activities will impact recreational fishing in the GOM. The space-use conflicts and the impacts of accidental events are similar to the impacts that will arise from the OCS Program. However, since recreational fishing activity usually occurs fairly close to shore, State activities that occur in popular fishing areas will have more noticeable impacts. For example, the impacts of artificial reefs and structure removals discussed above have the potential to have more noticeable effects in State waters.

Space-Use Conflicts

There are a variety of activities that could create space-use conflicts with recreational fishermen. Some of these activities include military vessel traffic, recreational vessel traffic, and commercial fishing activities. The extent of these conflicts would depend on their proximity to recreational fishing areas, which are often fairly close to shore.

Summary and Conclusion

A CPA proposed action and the broader OCS Program have varied effects on recreational fishing activity. The OCS Program has generally enhanced recreational fishing opportunities due to the role of oil platforms as artificial reefs. This effect depends importantly on the extent to which rigs are removed at decommissioning or are maintained through Rigs-to-Reefs programs. However, oil spills can have important negative consequences on recreational fishing activity due to the resultant fishing closures and longer-term effects oil spills can have on fish populations. These are discrete and rare events, however, and recreational fishing activity is largely driven by broader economic and tourism trends. Recreational fishing activity is also influenced by a number of non-OCS oil- and gas-related activities, particularly those that could impact fishing grounds such as wetlands areas. In addition, it is likely that Fisheries Management Plans of the Federal and State governments would serve to keep overall recreational fishing activity reasonably stable through time. The incremental contribution of a CPA proposed action to these positive and negative cumulative effects would be minimal.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

BOEM examined a variety of Internet sources, as well as known data providers, for new information regarding the impacts of a CPA proposed action on recreational fishing. The primary new data source is an annual update to recreational fishing data provided by NMFS (USDOC, NMFS, 2013f). This data source provides data on both the species caught and the amount of angler effort in any particular year. **Table 4-3** presents data on the number of angler trips taken in Louisiana, Mississippi, Alabama, and West Florida from 2008 to 2012. In these states combined, there were 24.8 million angler trips in 2008, 22.6 million angler trips in 2009, 21.0 million angler trips in 2010, 22.6 million angler trips in 2011, and 23.2 million angler trips in 2012. **Table 4-3** also breaks down these trips by location and mode. The three geographic locations for each state are inland, State ocean waters, and Federal ocean waters. The three modes of fishing are shore fishing, charter fishing, and private/rental fishing. For the Gulf as a whole, all forms of ocean-based fishing were higher in 2012 than in 2011. Shore-based and charter-based inland recreational fishing increased in 2012, while private/rental-based inland recreational fishing slightly decreased in 2012. Overall recreational fishing activity in West Florida and Mississippi was slightly higher in 2012 than in 2011, while recreational fishing activity in Alabama and Louisiana was slightly lower in 2012 than in 2011.

Table 4-4 presents data on the most commonly landed species by recreational fishermen (both in terms of numbers of fish and pounds of fish) in Louisiana, Mississippi, Alabama, and West Florida combined during each year from 2008 through 2012. Landings for most species were roughly consistent with landings observed in prior years. However, there were higher landings of species such as gray snapper (*Lutjanus griseus*), pinfishes (*Lagodon rhomboides*), and blackfin tuna (*Thunnus atlanticus*) in 2012 than in prior years. There were lower landings of species such as gag (*Mycteroperca microlepis*) and greater amberjack (*Seriola dumerili*).

The NMFS has also released its annual update to its *Fisheries Economics of the U.S. 2011* report (USDOC, NMFS, 2012). This report presents various data regarding the economic significance of recreational fishing in the Gulf of Mexico. **Table 4-5** presents data from this report on expenditures, sales, value added, and employment in each Gulf Coast State. Recreational fishing activity supported $9.8 billion in expenditures, $9.3 billion in sales, $4.8 billion in value added, and 89,319 jobs in the Gulf of Mexico in 2011. The largest economic impacts from recreational fishing occurred in West Florida. Louisiana and Texas had the next largest impacts, followed by Alabama and Mississippi.

4.1.1.21. Recreational Resources

BOEM has reexamined the analysis for recreational resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for recreational resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of recreational resources and the full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in the Chapter 4.2.1.21 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.21 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since the publication of these documents is presented below.

Impacts of Routine and Accidental Events

Routine OCS actions in the CPA can cause various disturbances to recreational resources. For example, marine debris can noticeably affect the aesthetic value of coastal areas, particularly beaches. Vessel noise and the visibility of OCS infrastructure can also conflict with some recreational activities. Similarly, vessel traffic can cause space-use conflicts with recreational activities. The OCS activities can also change the composition of local economies through changes in employment, land use, and demand for activities related to recreation and tourism. The presence of OCS oil and gas platforms can enhance some recreational activities such as fishing and diving, although the long-term impacts of platforms depend on the nature of the decommissioning of the platform. However, the small scale of a CPA proposed action relative to the scale of the existing oil and gas industry suggests that these potential impacts on recreational resources are likely to be minimal.

A detailed analysis of the routine impacts of a CPA proposed action on recreational resources can be found in Chapter 4.2.1.21.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.21 of the WPA 233/CPA 231 Supplemental EIS.

Accidental spills most likely to result from a CPA proposed action will be small, of short duration, and not likely to impact Gulf Coast recreational resources. Should an oil spill occur and contact a beach area or other recreational resource, it will cause some disruption during the impact and cleanup phases of the spill. Beaches, nature parks, and wetland areas could be impacted during these phases of a spill. These disruptions could also have impacts on firms and consumers that depend on the use of these resources. Media coverage and public perception regarding the extent of the oil damage can also influence the ultimate economic impacts of the spill. The economic impacts of a spill would be mitigated to some extent if a legal damage claims process were to be implemented subsequent to an oil spill. However, all of these effects would likely be small in scale and of short duration.

A detailed analysis of the accidental impacts of a CPA proposed action on recreational resources can be found in Chapter 4.2.1.21.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.21 of the WPA 233/CPA 231 Supplemental EIS.

Summary and Conclusion

BOEM has reexamined the analysis for recreational resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for recreational resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because the new information was roughly consistent with prior expectations. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The cumulative impacts to recreational resources would occur due to a CPA proposed action, the existing OCS Program, and various non-OCS events and actions. A CPA proposed action would contribute to a number of aesthetic, space-use, oil-spill, and infrastructure emplacement and removal impacts arising from existing and future oil and gas programs. Recreational resources along the Gulf Coast can also be impacted by non-OCS aesthetic and space-use conflicts, as well as a variety of other factors, such as coastal erosion, beach disruptions, impacts from military operations, and economic factors.

OCS Oil- and Gas-Related Impacts

Aesthetic Impacts

A CPA proposed action would contribute to effects of the overall OCS Program. For example, the 94,000-168,000 service-vessel trips and 696,000-1,815,000 helicopter operations that are projected to arise from a CPA proposed action would contribute to the 3,310,000-4,382,000 service-vessel trips and 28,710,000-55,605,000 helicopter operations that are projected to arise from the entire OCS Program from 2012 to 2051. These activities would have some aesthetic impacts on recreational resources. For example, the OCS Program contributes to the marine debris problems along the Gulf Coast. The BSEE guidance regarding marine debris prevention is outlined in NTL 2012-BSEE-G01, “Marine Trash and Debris Awareness and Elimination.” This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harms of discharging marine debris. This NTL also states that OCS workers should complete annual marine debris prevention training; operators are also instructed to develop a certification process for the completion of this training by their workers. These various laws and regulations will likely minimize the potential damage to recreational resources from the discharge of marine debris from non-OCS oil- and gas-related operations.

There are also potential negative impacts on beach tourism from vessel noise and from the visibility of OCS infrastructure. While the potential effects of noise on tourism are difficult to quantify, several characteristics of the OCS oil and gas industry serve to minimize these effects. First, most OCS oil- and gas-related vessel traffic moves between onshore support bases and production areas far offshore. Support bases are located in industrial ports, which are usually distant from recreational use areas. Second, OCS vessel use of approved travel lanes should keep noise fairly transitory and thus unlikely to noticeably impact tourism. The extent to which the visibility of an OCS platform would affect tourism would depend on the size and distance from shore of a particular platform.

Space-Use Conflicts

A CPA proposed action would also contribute to space-use conflicts between recreational activities and the broader OCS Program. Space-use conflicts could arise particularly near Port Fourchon (Lafourche Parish, Louisiana) due to the high concentration of the OCS oil and gas industry in this area. The vessel traffic near OCS facilities could cause space-use conflicts with boating and recreational fishing activities. However, even if a space-use conflict was to arise in a particular instance, it is likely that a number of substitute recreational sites would be available. In addition, given the entrenched nature of the OCS oil and gas industry along the Gulf Coast, it is unlikely that any particular OCS oil- and gas-related action would significantly add to space-use conflicts in this area.

Oil Spills

A CPA proposed action would contribute incrementally to the likelihood of an oil spill caused by the broader OCS Program. Accidental spills most likely will be small, of short duration, and not likely to impact Gulf Coast recreational resources. Should an oil spill occur and contact a beach area or other recreational resource, it will cause some disruption during the impact and cleanup phases of the spill. However, these effects are also likely to be small in scale and of short duration. An OCS oil- and gas-related activity could also contribute to the possibility of a low-probability catastrophic oil spill, which is not reasonably foreseeable and not part of a CPA proposed action; the impacts of a catastrophic oil spill on recreational resources are discussed in **Appendix B**.

Infrastructure Emplacement and Removal

Routine OCS oil- and gas-related actions can contribute to coastal erosion through activities such as channel dredging and pipeline emplacements. A more detailed discussion of the cumulative impacts of OCS oil- and gas-related actions on coastal beaches and dunes is presented in **Chapter 4.1.1.3**. Further information on the cumulative impacts of OCS oil- and gas-related activities on wetlands resources can be found in **Chapter 4.1.1.4**. These effects could cause impacts to recreational activities, such as fishing and wildlife viewing, which depend on beaches and wetland areas. However, platform emplacements can encourage some recreational activities, such as diving. However, decommissioning of these structures can have negative impacts on recreational diving if a particular platform were a popular diving site.

Non-OCS Oil- and Gas-Related Impacts

Aesthetic Impacts

Marine debris can noticeably affect the aesthetic value of coastal areas, particularly beaches. This is particularly true given the high levels of marine debris that already exist in some areas. Non-OCS oil- and gas-related marine debris can originate from State oil and gas activities, sewage treatment plants, recreational and commercial fishing, industrial manufacturing, cruise ships, and various forms of vessel traffic. Adler et al. (2009) present a broad overview of the nature of the marine debris problem. Various government agencies participate in a coordinated effort to combat marine debris; a broad summary of the issues involved and the policy structure with respect to marine debris can be found in the report of the Interagency Marine Debris Coordinating Committee (USDOC, NOAA, 2008). There is also a national monitoring program in place to track the progression of the marine debris problem in various locations. Ocean Conservancy (2007) describes the structure of the National Marine Debris Monitoring Program, as well as the methods used to measure marine debris on various coastlines. McIlgorm et al. (2009) present an economic analysis of the costs of marine debris and of programs designed to minimize debris. This study explains that marine debris has a particular impact on fishing activity, the shipping industry, tourism activity, and on activities related to marine ecosystems. The discharge of marine debris is subject to a number of laws and treaties. These include the Marine Debris Research, Prevention, and Reduction Act; the Marine Plastic Pollution Research and Control Act; and the MARPOL Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard.

Space-Use Conflicts

State oil and gas activities would contribute to the space-use and aesthetic conflicts experienced by the Gulf Coast. For example, State oil and gas platforms are closer to shore than OCS platforms and thus would be more likely to impact the viewshed from certain areas. State oil and gas helicopter and vessel traffic could would also have visual and noise impacts, which would have impacts on recreational experiences if those activities occur near popular recreation and tourism locations.

Beach/Wetland Erosion

The OCS Program occurs in an environment in which beach and wetland resources are undergoing depletion due to human development, hurricanes, and natural processes. An overview of issues related to coastal erosion can be found in *Evaluation of Erosion Hazards* (The Heinz Center, 2000). This study characterizes the changes in the shorelines along the United States (including the Gulf Coast), describes the National Flood Insurance Program, describes current approaches to erosion management, describes the economic impacts of erosion, and discusses various policy options. The ongoing risk of hurricanes is a particular coastal erosion threat in the Gulf of Mexico; coastal erosion also lessens protection against future hurricanes. More information regarding these issues can be found in **Chapters 4.1.1.3, 4.1.1.4, and 4.1.1.23.1**. Coastal erosion trends would have impacts on recreational resources to the extent that parts of these areas are used for recreational activities, such as beach visitation, recreational fishing, and boating.

Beach Disruptions

The recreational value of beaches can be affected by a variety of ocean processes. For example, red tides, which are caused by growth of microscopic algae, can negatively affect the aesthetic value of beaches. Red tides can also cause respiratory problems and skin irritation for beachgoers (Mote Marine Laboratory, 2013). The recreational value of beaches can also be negatively impacted by degradations of air quality and water quality (**Chapters 4.1.1.1 and 4.1.1.2**).

Military Operations

There are areas in the CPA where both OCS oil- and gas-related activities and military operations occur. Military operations in these areas can cause both space-use conflicts and aesthetic impacts to recreational resources. These effects would largely occur to offshore recreational activities such as boating, although aesthetic impacts could occur to onshore resources such as beaches if the military activities occurred close enough to these activities.

Impacts due to Economic Factors

The recreational resources along the Gulf Coast will be subject to various impacts arising from economic development. For example, there may be pressures to develop other industries into existing parks and natural resources. However, development may also encourage the expansion of other recreational resources, such as hotels and restaurants, to accommodate increased tourism and/or local recreation. The projected path of the economies along the Gulf Coast will be influenced by national economic trends. Recreational and tourism activity is positively correlated to the state of the overall economy, primarily because higher levels of disposable income encourage consumers to dedicate more money to travel and leisure activities. More information regarding economic factors can be found in **Chapter 4.1.1.23.3**.

Summary and Conclusion

A CPA proposed action would contribute to a number of aesthetic, space-use, oil spill, and infrastructure emplacement and removal impacts arising from existing and future oil and gas programs. Recreational resources along the Gulf Coast can also be impacted by non-OCS oil- and gas-related aesthetic and space-use conflicts, as well as a variety of other factors, such as coastal erosion, beach disruptions, and economic factors. However, the incremental contribution of a CPA proposed action is expected to be minimal in light of all OCS oil- and gas-related and non-OCS oil- and gas-related activities. This is because of the small scale of a CPA proposed action, as well as the fact that most impacts to recreational resources will be temporary.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

BOEM conducted a search of Internet sources and known data providers for new information regarding recreational resources. The Bureau of Labor Statistics has released final data regarding the scale of employment in various industries in Gulf Coast States in 2012 (U.S. Department of Labor, Bureau of Labor Statistics, 2013). **Table 4-6** presents data on the levels of employment in leisure and hospitality industries in various Economic Impact Areas (EIA's) and coastal areas. Leisure and hospitality employment was higher in 2012 than in any year from 2008 through 2011 in all EIA's and coastal areas. This is likely primarily due to the gradual improvement in overall economic conditions since the most recent economic recession.

Lowe and Stokes (2013) presents a variety of information regarding the scale of wildlife tourism in various Gulf Coast areas. For example, this report finds that over 1,100 wildlife guide businesses support over 11,000 dining and lodging businesses. This report also estimates that wildlife tourism along the Gulf Coast supports over $19 billion in spending and generates over $5 billion in Federal, State, and local tax revenues. The three primary forms of wildlife tourism are fishing (which supports $8 billion in spending), wildlife watching (which supports $6.5 billion in spending), and hunting (which supports $5 billion in spending). Wildlife tourism supports the most spending in Florida ($8 billion) and Texas ($5 billion); wildlife tourism supports approximately $2 billion in spending each in Louisiana, Mississippi, and Alabama.

New data regarding the extent of shoreline oiling arising from the *Deepwater Horizon* oil spill has become available (USDOC, NOAA, 2013d). These data show that the majority of the shoreline of Louisiana has been cleaned. However, some areas, particularly areas near Chandeleur Sound and Barataria Bay, still had areas of oiled shoreline (the data were as of October 24, 2013). Finally, Ocean Conservancy (2013) provides data regarding the levels of marine debris found on the coastlines of various states. The amounts of trash found on the coastlines of the states along the Gulf of Mexico were (the data are presented in terms of pounds of trash): Alabama (173,637); Florida (428,962); Louisiana (7,801); Mississippi (54,680); and Texas (305,560).

Incomplete or unavailable information related to recreational resources may be relevant to reasonably foreseeable adverse impacts on these resources, as described in this chapter and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. With regard to the *Deepwater Horizon* explosion, oil spill, and response, BOEM has determined that the incomplete or unavailable information would not be essential to a reasoned choice among alternatives for the reasons described herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

4.1.1.22. Archaeological Resources

4.1.1.22.1. Historic

BOEM has reexamined the analysis for historic archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for historic archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.22.1.2 and 4.2.1.22.1.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.22.1 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were prepared is presented below.

A detailed description of historic archaeological resources can be found in Chapter 4.2.1.22.1.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.22.1 of the WPA 233/CPA 231 Supplemental EIS.

Impacts of Routine and Accidental Events

Routine impact-producing factors associated with a CPA proposed action that could affect historical archaeological resources include direct physical contact with a shipwreck site; the placement of drilling rigs and production systems on the seafloor; pile driving associated with platform emplacement; pipeline placement; dredging of new channels, as well as maintenance dredging of existing channels; anchoring activities; pipeline installation; post-decommissioning trawling clearance; and the masking from geophysical sensors of archaeological resources from industry-related debris. A detailed impact analysis of the routine impacts from OCS activities associated with proposed CPA Leases Sale 235, 241, and 247 on historic archaeological resources can be found in Chapter 4.2.1.22.1.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.22.1 of the WPA 233/CPA 231 Supplemental EIS.

The greatest potential impact to an archaeological resource as a result of a CPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic site because of incomplete knowledge of the location of these sites in the Gulf. The risk of contact to archaeological resources is greater in instances where archaeological survey data are inadequate or unavailable. Such an event could result in the disturbance or destruction of important archaeological information. Archaeological surveys provide the necessary information to develop avoidance strategies that reduce the potential for impacts on archaeological resources.

Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, are expected to be effective at identifying possible archaeological sites. The technical requirements of the archaeological resource reports are detailed in NTL 2005-G07, "Archaeological Resource Surveys and Reports." Under 30 CFR § 550.194(c) lessees are required to immediately notify BOEM's Regional Director of the discovery of any potential archaeological resources. Under 30 CFR § 250.194(c) and 30 CFR § 250.1010(c), lessees are also required to immediately notify BSEE's Regional Director of the discovery of any potential archaeological resources.

Except for the projected 0-1 new gas processing facilities and 0-1 new pipeline landfalls, a CPA proposed action would require no new oil and gas coastal infrastructure. It is expected that archaeological resources would be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Impacts to documented and undocumented historic archaeological resources could occur as a result of an accidental oil spill and the associated cleanup operations. Should a spill contact a historic archaeological site (including submerged sites), damage might include contamination of materials, direct impact from oil-spill cleanup equipment, and/or looting. An additional major effect from an oil spill could be viewshed pollution of a historic coastal site, such as a fort or lighthouse. Although such effects may be temporary and reversible, cleaning oil from historic structures can be a complex, time-consuming, and expensive process, and the use of dispersants may result in long-term chemical contamination of submerged cultural heritage sites (e.g., Chin and Church, 2010). It is expected, however, that any spill cleanup operations would be considered a Federal action for the purposes of Section 106 of the National Historic Preservation Act and would be conducted in such a way as to minimize impacts to historic archaeological resources. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on historic archaeological resources can be found in Chapter 4.2.1.22.1.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.22.1 of the WPA 233/CPA 231 Supplemental EIS. Detailed risk analyses of offshore oil spills ranging from <1,000 bbl to ≥1,000 bbl and coastal spills associated with a CPA proposed action are provided in **Chapters 3.2.1.5, 3.2.1.6, and 3.2.1.7** of this Supplemental EIS and Chapters 3.2.1.5, 3.2.1.6, and 3.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS. When oil is spilled in offshore areas, much of the oil volatilizes or is dispersed by currents, so it has a low probability of contacting coastal areas.

Impacts to documented and undocumented historic archaeological resources could occur as a result of an accidental oil spill and the associated cleanup operations; however, the potential for spills is low, the effects would generally be localized, and the cleanup efforts would be regulated. A CPA proposed action, therefore, is not expected to result in impacts to historic archaeological sites; however, should such impacts occur, unique or significant archaeological information could be lost and this impact could be irreversible.

Summary and Conclusion

BOEM has reexamined the analysis for historic archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for historic archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because the only new relevant documentation describes the survey procedures undertaken by Shoreline Cleanup and Assessment Technique (SCAT) teams and a summation of site discoveries. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Information

Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, 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 sidescan sonar as well as a magnetometer. In areas of thicker unconsolidated sediments, shipwreck remains are more likely to be completely buried, with detection relying solely on magnetometry.

Of the cumulative scenario activities, those that could potentially impact historic archaeological resources include the OCS Program's routine and accidental impacts; OCS sand borrowing; artificial Rigs-to-Reefs development; offshore LNG projects; renewable energy and alternative-use conversions; oil-spill response and cleanup operations; new channel dredging and maintenance dredging; State oil and gas activity, artificial reef development, renewable energy and alternative-use conversions; commercial fishing trawling; sport diving and commercial treasure hunting; and natural processes, including wave action and hurricanes.

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas-related impact-producing factors that could potentially impact historic archaeological resources include the OCS Program's routine and accidental impacts (refer to Chapters 4.2.1.22.1.2 and 4.2.1.22.1.3 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.22.1 of the WPA 233/CPA 231 Supplemental EIS for more detail), artificial Rigs-to-Reefs development, and renewable energy and alternative-use conversions.

According to estimates presented in **Table 3-3**, between 2012 and 2051, an estimated 15,440-22,007 exploration, delineation, development, and production wells would be drilled and 1,435-2,026 production platforms would be installed as a result of the OCS Program. Of this range, between 6,110 and 8,720 exploration, delineation, production, and development wells would be drilled, and 1,210-1,720 production structures would be installed in water depths of 60 m (196 ft) or less. In support of a typical CPA lease sale, an estimated 168-329 exploration and delineation wells and 215-417 development and production wells would be drilled, and 35-67 production platforms would be installed (**Table 3-4**). Of this range, between 140 and 273 exploration, delineation, production, and development wells would be drilled and 28-54 production structures would be installed in water depths of 60 m (196 ft) or less. All of the lease blocks in this water depth have a high potential for historic shipwrecks. The potential of an interaction between an MODU or platform emplacement and a historic shipwreck is greatly diminished by requisite site surveys, where required, but it still exists in areas where surveys have not been required in the past or have been acquired at insufficient transect spacing. Such an interaction could result in the loss of or damage to significant or unique historic resources. Archaeological surveys provide the necessary information to develop avoidance strategies that reduce the potential for impacts on archaeological resources. Current archaeological survey guidance is provided in NTL 2005-G07 ("Archaeological Resource Surveys and Reports") and NTL 2011-JOINT-G01 ("Revisions to the List of OCS Lease Blocks Requiring Archaeological Resource Surveys and Reports"), and in BOEM's pre-seabed disturbance mitigation for the avoidance of archaeological resources (USDOI, BOEM, 2011).

Table 3-3 indicates that the placement of between 30,428 and 69,749 km (18,907-43,340 mi) of pipelines is projected in the cumulative activity area for 2012-2051. 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, when required, 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 have occurred in the past and may occur again. In 2004 an anchor associated with an exploration well was dragged across the wreck of the World War II-era tanker *Gulfstag*, due in part to inadequate survey coverage of the area Such an interaction can result in the loss of or damage to significant or unique historic resources and the scientific information they contain.

The OCS sand borrowing is expected to increase in volume during the OCS cumulative activities period. Approximately 76 million yd^3 of OCS sand are liable to be accessed for coastal restorations over the next 5-10 years, primarily from Ship Shoal Blocks 88 and 89 and from South Pelto Blocks 12 and 13. For this type of bottom-disturbing activity, a preconstruction archaeological survey is required by BOEM for the borrow site lease. These surveys are expected to be effective at identifying potential cultural resources within the sand borrow area and at establishing proper dredging setback distances for these potential resources. No new disturbance of historic shipwrecks would be expected when these surveys are conducted and the setback distances adhered to.

The Rigs-to-Reefs program, offshore LNG projects, and renewable energy projects and alternative-use conversions are expected to remain at, respectively, a steady pace of activity, to decrease, and to increase as competing uses of the OCS. A preconstruction archaeological survey is typically required before bottom-disturbing activities are permitted for new artificial reef placement areas, deepwater ports for LNG facilities, and newly built renewable energy facilities. Alternative-use conversions of existing infrastructure likely would not involve new bottom-disturbing activities; for permit applications that do involve new bottom-disturbing activities, a preconstruction survey would be required. No new disturbance of historic shipwrecks would be expected when these surveys are conducted and when proper setback distances of potential resources are adhered to.

Past, present, and future OCS oil and gas exploration and development would result in the deposition of a significant mass of steel debris on the seafloor. The loss or discard of steel debris associated with oil and gas exploration and development, and trawling activities could result in the masking of historic shipwrecks or the identification of false negatives on archaeological surveys (an anomaly that does not appear to be of historical significance, but actually is). Such masking of the signatures characteristic of historic shipwrecks may have resulted or may yet result in OCS oil- and gas-related activities in the cumulative activity area impacting a shipwreck containing significant or unique historic information.

The probabilities of offshore oil spills ≥1,000 bbl occurring from OCS Program activities is presented in Chapter 3.2.1.5.1 and Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS. Oil spills have the potential to impact submerged or coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. Table 3-23 of the 2012-2017 WPA/CPA Multisale EIS presents coastal spills categorized by source. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of OCS oil- and gas-related commercial and recreational activities remain the same. Should such oil spills contact a historic site, the effects may be temporary and reversible; however, cleaning oil from historic structures can be a complex, time-consuming, and expensive process, and the use of dispersants may result in long-term chemical contamination of submerged cultural heritage sites (e.g., Chin and Church, 2010). Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B**.

Non-OCS Oil- and Gas-Related Impacts

The non-OCS oil- and gas-related impact-producing factors that could potentially impact historic archaeological resources include State oil and gas activity; offshore LNG projects; new channel dredging and maintenance dredging; State renewable energy and alternative-use conversions; State artificial reefs and Rigs-to Reefs development; commercial fishing, sport diving, and commercial treasure hunting; and natural processes, including wave action and hurricanes.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high potential for historic shipwrecks, and 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, COE requires remote-sensing surveys prior to dredging activities to minimize such impacts. Maintenance dredging takes place in existing, often well-used, and marked seaways and transit corridors. Any historic wrecks within maintenance dredged areas would have been already disturbed or their historical context destroyed. Routine maintenance dredging, as an ongoing activity in heavily trafficked channels, is not likely to result in any new disturbance or disruption to historic wrecks.

Within State waters, oil- and gas-related activities, sand borrow projects, renewable energy projects, artificial reef creation, and alternative-use conversions are not under the jurisdiction of BOEM with respect to the archaeological resource protection requirements of the National Historic Preservation Act (NHPA). Under the NHPA, other Federal agencies, such as COE, which issues permits associated with pipelines and sand borrow projects in State waters, are responsible for taking into consideration the effects of activities permitted by such agencies on archaeological resources. Therefore, the impacts that might occur to archaeological resources by pipeline construction, sand borrowing, renewable energy infrastructure, or alternative-use conversions within State waters should be mitigated under the requirements of the NHPA. Any activities resulting in new bottom disturbances may require a pre-clearance archaeological survey at the discretion of the State or lead Federal agency.

Past, present, and future oil and gas exploration and development within State waters, renewable energy development, LNG processing facilities, and commercial fishing trawling would also result in the deposition of tons of steel debris on the seafloor. Modern marine debris associated with these activities may 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 non-OCS oil- and gas-related activities in the cumulative activity area impacting a shipwreck containing significant or unique historic information.

Commercial fishing trawling activity may also have a direct impact on historic shipwrecks resulting from contact between a wreck and trawl nets. This activity specifically would only affect the uppermost portions of the sediment column (Garrison et al., 1989) in water depths generally <600 ft (183 m). Many wooden-hulled wrecks in these areas may be buried below the expected depth of sediment column impacts or may already be disturbed by natural factors that have minimized the wreck's archaeological context.

Sport diving, which is generally restricted to water depths <130 ft (40 m), 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 Florida Keys National Marine Sanctuary and the Florida Public Archaeology Network, 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 within their diving limits. Since the extent of these activities is unknown, the impact cannot be quantified. A Spanish war vessel, *El Cazador*, was discovered in the CPA; it contained a large amount of silver coins and has been impacted by treasure hunting salvage operations (McLaughlin, 1995). Another vessel, the 19th-century steamship *New York*, was discovered in the WPA in the 1990's. This wreck has also been subjected to extensive impacts related to treasure hunting salvage of coins, shipboard artifacts and personal artifacts (Gearhart et al., 2011). The historic data available from these wrecks and from other wrecks that have been impacted by treasure hunters and sport divers represent a localized significant or unique loss of archaeological information.

Shipwrecks and other historic archaeological sites in shallow waters may be eroded and dispersed by normal coastal wave activity, which is intensified during hurricanes and tropical storms. On average, 15-20 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 northwestern Gulf from the effects of tropical storms. Some of the data lost have most likely been significant or unique. Hurricane-induced damage to shipwrecks sunk as artificial reefs have been observed in over 200 ft (61 m) of water (Gearhart et al., 2011).

Summary and Conclusion

Several impact-producing factors may threaten historic archaeological resources, all related to bottom-disturbing activities. An impact could result from contact between a historic shipwreck and OCS Program or State oil and gas activities (i.e., pipeline and platform installations, drilling rig emplacement and operation, dredging, anchoring activities, structure removal, and site clearance). Bottom-disturbing activities on the OCS and within State waters also may include maintenance dredging, sand borrowing, transported artificial reef emplacement, liquefied natural gas facility construction, and renewable energy facility construction. With the exception of maintenance dredging, preconstruction surveys may be required by BOEM or the lead Federal permitting agency. Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a historic resource. Impacts resulting from the imperfect knowledge of the location of historic resources, however, may still occur in areas where a high-resolution survey is conducted at insufficient transect spacing or not at all. The loss or discard of steel debris associated with oil and gas exploration and development and trawling activities could result in the masking of historic shipwrecks or the identification of false negatives on archaeological surveys (an anomaly that does not appear to be of historical significance, but actually is).

Non-OCS oil- and gas-related factors that may impact historic shipwrecks include maintenance dredging, commercial fishing trawling, sport-diving and treasure hunting, and hurricanes and tropical storms. It is expected that these elements have impacted and will continue to impact historic period shipwrecks on the shelf where such activities occur, and independent of a CPA lease sale.

Development onshore as a result of a CPA proposed action could result in the direct physical contact between a historic site and pipeline trenching. Such activities are not under the jurisdiction of BOEM with respect to the archaeological resource protection requirements of the NHPA and would instead be the responsibility of other Federal agencies, which issue permits associated with pipelines in State waters. It is assumed that archaeological investigations prior to construction would serve to satisfy the lead agency's NHPA requirements and to mitigate these potential impacts. Therefore, the impacts that might occur to archaeological resources by pipeline construction originating from OCS oil- and gas-related activity within State waters should be mitigated under the requirements of the NHPA, and the same archaeological surveys for planned pipelines that lead into a landfall or a tie-in to a pipeline in State waters are required. Oil spills have the potential to impact coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past. Recent research suggests the impact of direct contact of oil on historic properties may be long term and not easily reversible without risking damage to fragile historic materials (Chin and Church, 2010). Damage to or loss of significant or unique historic archaeological information from commercial fisheries (i.e., trawling) is highly likely in water depths <600 ft (183 m) (Foley, 2010).

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the localized loss of significant or unique historic archaeological information. In the case of factors related to OCS Program activities within the cumulative activity area, it is reasonable to assume that most impacts would have occurred where development occurred prior to any archaeological survey requirements. The incremental contribution of a CPA proposed action is expected to be very small due to the efficacy of remote-sensing surveys and archaeological reports, where required. Future OCS Program activities and the bottom-disturbing activities permitted by BOEM and other agencies may require preconstruction archaeological surveys that, when completed, are highly effective in identifying bottom anomalies that could be avoided or investigated before bottom-disturbing activities begin. When surveys are not required, it is impossible to anticipate what might be imbedded in or lying directly on the seafloor, and impacts to these sites are likely to be major in scale. Despite diligence in site-clearance survey reviews, there is still the possibility of an unanticipated interaction between bottom-disturbing activity (i.e., rig emplacement, pipeline trenching, anchoring, and other ancillary activities) and a historic shipwreck.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources, as well as interviews with Larry Murphy, Historic Properties Specialist Officer for the Section 106 response to the *Deepwater Horizon* explosion, oil spill, and response, and Dan Odess, DOI Consulting Archaeologist, were conducted to determine the availability of recent information. Various Internet sources were examined to assess recent information regarding impacts to archaeological resources or potential new threats to archaeological resources that may be pertinent to the CPA. These Internet sources included various online indexes to periodical literature, such as EBSCO Online (http://web.ebscohost.com), JSTOR (http://www.jstor.org/), the National Technical Information Service's National Technical Reports Library (https://ntrlr3.ntis.gov), and ScienceDirect (http://www.sciencedirect.com/). A 2011 interim report describes activities to support response activities related to the *Deepwater Horizon* explosion, oil spill, and response and to evaluate the impact or potential impact of the event and subsequent cleanup operations to previously recorded and unidentified cultural resources. This cultural resources undertaking involves both Federal and State agencies within the States of Louisiana, Mississippi, Alabama, and Florida. The cultural resources investigation for the *Deepwater Horizon* explosion, oil spill, and response was managed as a component of the SCAT process, and archaeologists have been involved throughout this process. Cultural resources investigations utilized a combination of pedestrian surveys, shovel testing, auger test sampling, and trench sampling. In addition, archaeological and Tribal monitors have been embedded with all cleanup operations. This report summarizes the findings of the pre-field investigations, field surveys, and cleanup monitoring associated with the response to the *Deepwater Horizon* explosion and oil spill through March 31, 2011 (HDR, 2011).

In April 2012, BOEM, working with NOAA's Office of Ocean Exploration and Research from the research vessel *Okeanos Explorer*, investigated a sonar target reported by Shell Oil in over 4,000 ft (1,200 m) of water in an area of the CPA almost 200 mi (320 km) offshore where an archaeological survey had previously not been required. The target proved to be the intact remains of an armed sailing ship dating from around 1790 to 1840. The following year in July 2013, BOEM participated in an expedition that identified two additional shipwrecks from the same time period less than 4 mi (6 km) away that also had been reported by Shell Oil as sonar targets. These discoveries highlight situations where site-specific surveys prior to bottom-disturbing activities may mitigate potential impacts, and they reinforce BOEM's need to acquire imagery of the seafloor in order to make informed management decisions during its NEPA analyses.

Although there is incomplete or unavailable information on reasonably foreseeable impacts to historic archaeological resources, BOEM feels that this information is not essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The locations of many archaeological resources remain unknown, some resources are buried under heavy sedimentation and therefore likely protected from many impacts, and archaeological surveys, where required, are expected to be highly effective in identifying resources to allow for protection of the resource during oil and gas activities. Nevertheless, this incomplete or unavailable information is not likely to be available within the timeline contemplated in the NEPA analysis of this Supplemental EIS. Hundreds of known historic archaeological resources are scattered throughout the Gulf of Mexico and thousands more may exist, but their locations are unknown to date. The costs of a Gulfwide study would be exorbitant, and it could take years before data confirming the presence of additional historic archaeological resources and the status of each could be compiled and analyzed. In place of this incomplete or unavailable information, BOEM's subject-matter experts have included what credible scientific information is available and applied it using accepted scientific methodologies as noted herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

4.1.1.22.2. Prehistoric

BOEM has reexamined the analysis for prehistoric archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for prehistoric archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with the CPA proposed action are presented in Chapters 4.2.1.22.2.2 and 4.2.1.22.2.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.22.2 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

A detailed description of prehistoric archaeological resources can be found in Chapter 4.2.1.22.2.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information provided in Chapter 4.2.1.22.2 of the WPA 233/CPA 231 Supplemental EIS.

Impacts of Routine and Accidental Events

Offshore development as a result of a CPA proposed action could result in an interaction between a drilling rig, platform, pipeline, dredging activity, 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. A detailed impact analysis of the routine impacts of OCS activities that may be associated with proposed CPA Lease Sales 235, 241, and 247 on prehistoric archaeological resources can be found in Chapter 4.2.1.22.2.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.22.2 of the WPA 233/CPA 231 Supplemental EIS.

Prehistoric archaeological sites are thought to be preserved shoreward of the 45-m (148-ft) bathymetric contour, where the Gulf of Mexico continental shelf was exposed during the Late Pleistocene. The greatest potential impact to an archaeological resource as a result of a CPA proposed action would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, dredging, pipeline emplacement) and a prehistoric site. Archaeological surveys provide the necessary information to develop avoidance strategies that reduce the potential for impacts on archaeological resources.

Archaeological survey and archaeological clearance of sites, where required prior to an operator beginning oil and gas activities on a lease, are expected to be somewhat effective at identifying submerged landforms that could support possible archaeological sites. The NTL 2005-G07 suggests a 300-m (984-ft) line spacing for remote-sensing surveys of leases within areas having a high potential for prehistoric sites. While surveys, where required, provide a reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric archaeological site, there is a possibility of an OCS activity contacting an archaeological site because of an insufficiently dense survey grid. Should such contact occur, there would be damage to or loss of significant and/unique archaeological information.

Impacts to documented and undocumented prehistoric archaeological resources could occur as a result of an accidental oil spill and the associated cleanup operations. Should a spill contact a prehistoric 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. Detailed risk analyses of offshore oil spills ranging from <1,000 bbl to ≥1,000 bbl and coastal spills that may be associated with a CPA proposed action is provided in **Chapters 3.2.1.5, 3.2.1.6, and 3.2.1.7** of this Supplemental EIS and Chapters 3.2.1.5, 3.2.1.6 and 3.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS. When oil is spilled in offshore areas, much of the oil volatilizes or is dispersed by currents, so it has a low probability of contacting coastal and barrier island prehistoric sites as a result of a CPA proposed action. A CPA proposed action, therefore, is not expected to result in impacts to prehistoric archaeological sites.

Oil spills resulting from a well blowout in the CPA and related spill-response activities have the potential to impact cultural resources near the spill site and landfall areas. A detailed impact analysis of the accidental impacts OCS activities that may be associated with proposed CPA Lease Sales 235, 241, and 247 on prehistoric archaeological resources can be found in Chapter 4.2.1.22.2.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.22.2 of the WPA 233/CPA 231 Supplemental EIS.

Summary and Conclusion

BOEM has reexamined the analysis for prehistoric archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for prehistoric archaeological resources presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because the only new relevant document describes the survey procedures undertaken by SCAT teams and a summation of site discoveries. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Information

Prehistoric archaeological sites are thought potentially to be preserved shoreward of the 45-m (148-ft) bathymetric contour, where the Gulf of Mexico continental shelf was exposed during the Late Pleistocene. Archaeological surveys, where required prior to an operator beginning oil and gas activities on a lease, are expected to be somewhat effective at identifying submerged landforms that could support possible prehistoric archaeological sites. While surveys provide a reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric archaeological site, there is still a possibility of an OCS oil- and gas-related activity contacting an archaeological site. Should such impacts occur, there could be damage to or loss of significant and/or unique archaeological information.

Of the cumulative scenario activities, those that could potentially impact prehistoric archaeological resources include the OCS Program’s routine and accidental impacts; OCS sand borrowing; artificial Rigs-to-Reef development; renewable energy and alternative-use conversions; oil-spill response and cleanup operations; new channel dredging and maintenance dredging; State oil and gas activity, artificial reef development, renewable energy and alternative-use conversions; commercial fishing trawling; and natural processes, including wave action and hurricanes.

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas-related impact-producing factors that could potentially impact prehistoric archaeological resources include the OCS Program’s routine and accidental impacts (refer to Chapters 4.2.1.22.2.2 and 4.2.1.22.2.3 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.22.2 of the WPA 233/CPA 231 Supplemental EIS for more detail); renewable energy and alternative-use conversion; and artificial Rigs-to-Reefs development.

According to estimates presented in **Table 3-3**, between 2012 and 2051, an estimated 15,440-22,007 exploration, delineation, development, and production wells would be drilled, and 1,435-2,026 production platforms would be installed as a result of the OCS Program. Of this range, between 6,110 and 8,720 exploration, delineation, production, and development wells would be drilled and 1,210-1,720 production structures would be installed in water depths of 60 m (196 ft) or less. In support of a typical CPA lease sale, an estimated 168-329 exploration and delineation wells and 215-417 development and production wells would be drilled, and 35-67 production platforms would be installed (**Table 3-4**). Of this range, between 140 and 273 exploration, delineation, production, and development wells would be drilled, and 28-54 production structures would be installed in water depths of 60 m (196 ft) or less. Relative sea-level curves for the Gulf of Mexico indicate there is no potential for the occurrence of prehistoric archaeological sites in water depths >60 m (196 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 by providing the necessary information to develop avoidance strategies. The potential of an interaction between rig or platform emplacement and a prehistoric site is diminished by the survey, but it still exists in areas where surveys have not been required in the past or have been acquired at insufficient transect spacing. Such an interaction could result in the loss of or damage to significant or unique prehistoric information. Archaeological surveys provide the necessary information to develop avoidance strategies that reduce the potential for impacts on archaeological resources. Current archaeological survey guidance is provided in NTL 2005-G07 ("Archaeological Resource Surveys and Reports") and NTL 2011-JOINT-G01 ("Revisions to the List of OCS Lease Blocks Requiring Archaeological Resource Surveys and Reports"), and in BOEM's pre-seabed disturbance mitigation for the avoidance of archaeological resources (USDOI, BOEM, 2011).

Table 3-3 indicates that the placement of between 30,428 and 69,749 km (18,907 and 43,340 mi) of pipelines is projected in the cumulative activity area for 2012-2051. While archaeological surveys minimize 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 in water depths <60 m (197 ft). 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 OCS sand borrowing is expected increase in volume during the OCS cumulative activities period. Approximately 76 million yd^3 (58 million m^3) of OCS sand are liable to be accessed for coastal restorations over the next 5-10 years, primarily from Ship Shoal Blocks 88 and 89 and from South Pelto Blocks 12 and 13. For these types of bottom-disturbing activities, a preconstruction archaeological survey is required by BOEM for the borrow site lease. These surveys are expected to be effective at identifying potential cultural resources within the sand borrow area and at establishing proper dredging setback distances for these potential resources. No new disturbance of prehistoric archaeological resources would be expected when these surveys are conducted and the setback distances adhered to.

The Rigs-to-Reefs program, renewable energy projects, and alternative-use conversions are expected to remain at, respectively, a steady pace of activity, to decrease, and to increase as competing uses of the OCS. A preconstruction archaeological survey is typically required before bottom-disturbing activities are permitted for new artificial reef placement areas and newly built renewable energy facilities. Alternative-use conversions of existing infrastructure likely would not involve new bottom-disturbing activities; for permit applications that do involve new bottom-disturbing activities, a preconstruction survey would be required. No new disturbance of prehistoric sites would be expected when these surveys are conducted and when proper setback distances of potential resources are adhered to.

The probabilities of offshore oil spills ≥1,000 bbl occurring from the OCS Program in the cumulative activity area are presented in Chapter 3.2.1.5.1 and Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS. 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 3-23 of the 2012-2017 WPA/CPA Multisale EIS and are categorized by source. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past, as long as the level of energy-related, commercial, and recreational activities remain the same. 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 partially 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. Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B**.

Non-OCS Oil- and Gas-Related Impacts

The non-OCS oil- and gas-related impact-producing factors that could potentially impact prehistoric archaeological resources include State oil and gas activity, new channel dredging and maintenance dredging, State renewable energy and alternative-use conversions, State artificial reefs and Rigs-to-Reefs development, OCS sand borrowing, offshore LNG projects, commercial fishing, and natural processes, including wave action and hurricanes.

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 and associated archaeological data were unique or significant. In many areas, regulatory agencies require surveys prior to dredging activities to minimize such impacts. Maintenance dredging takes place in existing, often well-used, and marked seaways and transit corridors. Any prehistoric sites within maintenance dredged areas would have been already disturbed or their historical context destroyed. Routine maintenance dredging, as an ongoing activity in heavily trafficked channels, is not likely to result in any new disturbance or disruption to prehistoric sites.

Within State waters, oil- and gas-related activities, sand borrow projects, renewable energy projects, artificial reef creation, and alternative-use conversions are not under the jurisdiction of BOEM with respect to the archaeological resource protection requirements of the NHPA. Under the NHPA, other Federal agencies, such as COE, which issues permits associated with pipelines and sand borrow projects in State waters, are responsible for taking into consideration the effects of activities permitted by such agencies on archaeological resources. Therefore, the impacts that might occur to prehistoric archaeological resources by pipeline construction, sand borrowing, LNG processing facility construction, State oil and gas infrastructure construction, renewable energy infrastructure construction, or alternative-use conversions within State waters should be mitigated under the requirements of the NHPA. Any activities resulting in new bottom disturbances may require a pre-clearance archaeological survey at the discretion of the State or lead Federal agency.

Commercial fishing trawling activity may also have an impact on prehistoric archaeological sites in State waters, resulting from contact between a site and trawl nets. This activity specifically would only affect the uppermost portions of the sediment column (Garrison et al., 1989). Most, if not all, of the prehistoric resources in these areas may be buried below the expected depth of sediment column impacts or would otherwise already be disturbed by natural factors that have minimized the resources' archaeological context through wave-based erosion and redeposition.

Submerged prehistoric archaeological sites will be eroded and dispersed by normal coastal wave activity, which is intensified during hurricanes and tropical storms. Over 100 hurricanes have made landfalls along the northern Gulf of Mexico coast from the Florida Panhandle to Texas over the past century (Liu and Fearn, 2000; Keim and Muller, 2009). 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, 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 contact between proposed oil and gas activities (including pipeline construction, platform installation, drilling rig emplacement and operation, dredging, and anchoring activities) and an oil spill and subsequent cleanup efforts. Each of these activities or events could damage and destroy a prehistoric archaeological site located on the continental shelf. Archaeological surveys, where required, and the resulting archaeological analyses completed prior to an operator beginning oil and gas activities on a lease are expected to be highly effective at identifying possible prehistoric sites. The OCS development has possibly impacted sites containing significant or unique prehistoric information in areas where surveys have not been required in the past or have been acquired at insufficient transect spacing. It is also possible that, even with current survey methods, prehistoric archaeological sites may be missed. No significant new information was found at this time that would alter the overall conclusion that cumulative impacts on prehistoric archaeological sites associated with a CPA proposed action is expected to be minimal. 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 localized loss of significant or unique 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 would 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 localized losses 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 have occurred in areas where surveys have not been required in the past or have been acquired at insufficient transect spacing. The incremental contribution of a CPA proposed action is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources, as well as interviews with Larry Murphy, Historic Properties Specialist Officer for the Section 106 response to the *Deepwater Horizon* explosion, oil spill, and response, and Dan Odess, DOI Consulting Archaeologist, were conducted to determine the availability of recent information. Various Internet sources were examined to assess recent information regarding impacts to archaeological resources or potential new threats to archaeological resources that may be pertinent to the CPA. These Internet sources included various online indexes to periodical literature such as EBSCO Online (http://web.ebscohost.com), JSTOR (http://www.jstor.org/), the National Technical Information Service's National Technical Reports Library (https://ntrlr3.ntis.gov), and ScienceDirect (http://www.sciencedirect.com/). A 2011 interim report describes activities to support response activities related to the *Deepwater Horizon* explosion, oil spill, and response and to evaluate the impact or potential impact of the event and subsequent cleanup operations to previously recorded and unidentified cultural resources. This cultural resources undertaking involves both Federal and State agencies within the States of Louisiana, Mississippi, Alabama, and Florida. The cultural resources investigation for the *Deepwater Horizon* explosion, oil spill, and response was managed as a component of the SCAT process, and archaeologists have been involved throughout the SCAT process. Cultural resources investigations utilized a combination of pedestrian surveys, shovel testing, auger test sampling, and trench sampling. In addition, archaeological and Tribal monitors have been embedded with all cleanup operations. This report summarizes the findings of the pre-field investigations, field surveys, and cleanup monitoring associated with the response to the *Deepwater Horizon* explosion and oil spill, up until March 31, 2011 (HDR, 2011).

Although there is incomplete or unavailable information on reasonably foreseeable impacts to prehistoric archaeological resources, BOEM feels that this information is not essential to a reasoned choice among alternatives for the reasons stated herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The locations of many prehistoric archaeological resources remain unknown, and those that have been identified are subject to Federal and State protections. Nevertheless, this incomplete or unavailable information is not likely to be available within the timeline contemplated in the NEPA analysis of this Supplemental EIS. There are numerous prehistoric archaeological resources scattered throughout the Gulf of Mexico and more may exist, but their locations and conditions are unknown to date. The costs of a Gulfwide study would be exorbitant and it could take years before data confirming the presence of additional prehistoric archaeological resources and the status of each could be compiled and analyzed. In place of this incomplete or unavailable information, BOEM's subject-matter experts have included what credibly scientific information is available and applied it using accepted scientific methodologies as noted herein and in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

4.1.1.23. Human Resources and Land Use

4.1.1.23.1. Land Use and Coastal Infrastructure

BOEM has reexamined the analysis for land use and coastal infrastructure presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for land use and coastal infrastructure presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

A detailed description of land use and coastal infrastructure can be found in Chapter 4.2.1.23.1.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.1 of the WPA 233/CPA 231 Supplemental EIS. The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapters 4.2.1.23.1.2 and 4.2.1.23.1.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.1 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

Impacts of Routine and Accidental Events

Many of the impacts of the *Deepwater Horizon* explosion, oil spill, and response to land use and infrastructure have been temporary and short-term, such as the ship decontamination sites and the waste staging areas established in the immediate aftermath of the *Deepwater Horizon* explosion, oil spill, and response (USDOT, Bureau of Transportation Statistics, 2010). These indirect effects on infrastructure had a short-term impact on the industry, and development drilling activity is expected to grow as several projects go online. Gulf of Mexico OCS oil production averaged 1.27 MMbbl of oil per day in 2013, which is unchanged from 2012. The Energy Information Administration forecasts GOM production of 1.38 MMbbl of oil per day in 2014 and 1.59 MMbbl of oil per day in 2015. Production growth in 2014 comes from eight projects expected to come online: Jack; St. Malo; Entrada; Big Foot; Tubular Bells; Atlantis Phase 2; Hadrian South; and Lucius. Further production growth in 2015 comes from an additional 10 projects: Axe; Cardamom Deep; Dalmatian; Deimos South; Kodiak; Pony; Samurai; West Boreas; Winter; and Mars B (USDOE, Energy Information Administration, 2014). In the future, the long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response will be clearer as time allows the production of peer-reviewed research and targeted studies that determine those impacts. The *Deepwater Horizon* explosion (and subsequent oil spill and response) was a low-probability catastrophic event. Many non-OCS oil- and gas-related factors contribute substantially to the baseline conditions for existing land use and coastal infrastructure, including, but not limited to, housing and other residential developments; the development of private and publicly owned recreational facilities; the construction and maintenance of industrial facilities and transportation systems; urbanization; city planning and zoning; changes to public facilities such as water, sewer, educational, and health facilities; changes to military bases and reserves; changes in population density; changes in State and Federal land use regulations; and changes in non-OCS oil- and gas-related demands for water transportation systems and ports.

The impacts of routine events associated with a CPA-proposed action are expected to remain at historic activity levels. The OCS oil- and gas-related infrastructure has developed over many decades and is an extensive and mature system that provides support for offshore activities. The expansive presence of this coastal infrastructure is the result of long-term industry trends, and it is not subject to rapid fluctuations. Relatively low operating costs in the Gulf of Mexico and a stable regulatory regime make the region both a more profitable and a more stable operating environment for service contractors than places such as Brazil and Africa (Bloomberg, 2013). BOEM projects 0-1 new gas processing facilities and 0-1 new pipeline landfalls for a CPA proposed action. However, based on the most current information available, there is only a very slim chance that either would result from a CPA proposed action; and, if a new, greenfield gas processing facility or pipeline landfall were to result, it would likely occur toward the end of the 40-year analysis period. The likelihood of a newbuild gas processing facility or pipeline landfall is much closer to zero than to one (Dismukes, official communication, 2013b). Because of the current near zero estimates for a pipeline landfall and gas processing facility construction, the routine activities associated with a CPA proposed action would have little effect on land use. BOEM anticipates that there would be maintenance dredging of navigation channels, provided funding is appropriated, in support of routine activity at services bases as a result of a CPA proposed action. In regard to land use and infrastructure, it does not appear that there would be adverse impacts from routine events associated with a CPA proposed action.

Accidental events (impact-producing factors) associated with a CPA proposed action that could affect land use and coastal infrastructure include, but are not limited to, oil spills, vessel collisions, and chemical/drilling-fluid spills. Accidental events associated with a CPA proposed action would occur at differing levels of severity, based in part on the location and size of event. The *Deepwater Horizon* explosion, oil spill, and response resulted in the implementation of new drilling and environmental safeguards adopted by industry. These new safeguards have reduced the probability of a low- probability catastrophic spill, which is not reasonably foreseeable and not part of a CPA proposed action. Such low-probability catastrophic events should be distinguished from accidental events that are smaller in scale and that occur more frequently. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on land use and coastal infrastructure can be found in Chapter 4.2.1.23.1.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.1 of the WPA 233/CPA 231 Supplemental EIS.

Summary and Conclusion

BOEM has reexamined the analysis for land use and coastal infrastructure presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. BOEM has determined that the additional information does not alter the impact conclusion for land use and coastal infrastructure because the plans to build the new gas-to-liquids facility are very preliminary and are dependent upon not only the outcome of the 18-month feasibility study but also because of future fluctuations in the natural gas supply market. Therefore, the analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The cumulative analysis considers impacts that may result from a CPA proposed action within the context of OCS oil- and gas-related and non-OCS oil- and gas-related impacts, and future OCS lease sales. The non-OCS oil- and gas-related factors consist of prior, current, and future OCS lease sales, as well as other impact-producing factors not related to the OCS oil and gas leasing program. The OCS oil- and gas-related impacts include a proposed action and the OCS Program, onshore waste disposal, and the *Deepwater Horizon* explosion, oil spill, and response. Non-OCS oil- and gas-related impacts include State oil and gas activity, downstream activities, coastal erosion and subsidence, and coastal storms. Many non-OCS oil- and gas-related factors contribute substantially to the cumulative impacts to land use and coastal infrastructure, including the following: housing and other residential developments; the development of private and publicly owned recreational facilities; the construction and maintenance of industrial facilities and transportation systems; urbanization; city planning and zoning; changes to public facilities such as water, sewer, educational, and health facilities; changes to military bases and reserves; changes in population density; changes in State and Federal land use regulations; and changes in non-OCS oil- and gas-related demands for water transportation systems and ports. Chapter 4.2.1.23.1.1 of the 2012-2017 WPA/CPA Multisale EIS and updated information provided Chapter 4.2.1.23.1 of the WPA 233/CPA 231 Supplemental EIS discuss the socioeconomic analysis area, land use, and OCS oil- and gas-related infrastructure associated with the analysis area. The vast majority of this infrastructure also supports oil and gas production in State waters, as well as in coastal areas onshore.

According to BOEM's development scenario analysis, the construction of 0-1 new gas processing facilities would be expected to occur near the end of the 40-year life of a CPA proposed action. Most new pipelines would be offshore and would tie into the existing offshore pipeline infrastructure.

According to the scenario analysis, 0-1 new pipeline landfalls would be expected to occur toward the end of the 40-year lifespan of a CPA proposed action. Those projections also called for no new waste disposal facilities due to existing excess capacity along the Gulf Coast. Research based on the analysis of historical data further validated BOEM's past scenario projections of new gas processing facilities and new pipeline landfalls and found its projections to be conservative; that is, the actual numbers proved to be equal to, or less than, the projected numbers (Dismukes et al., 2007). Current scenario projections are also likely to be conservative (Dismukes, official communication, 2013b).

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas-related onshore coastal infrastructure is extensive, covers a wide-ranging area, supports OCS development, and is owned, operated, maintained, and/or utilized by thousands of large and small companies. Lease sales will serve mostly to maintain ongoing activity levels associated with the current OCS Program. Industry will more or less maintain its current usage of infrastructure according to the proposed lease sale schedule. Macroeconomic shifts, such as a change in commodity prices or an economic upturn or downturn, will also determine future utilization of this infrastructure.

These industries cover every facet of OCS activity, including, but not limited to, the following: service bases; helicopter hubs; platform fabrication yards; shipbuilding and shipyards; pipecoating facilities and yards; refineries; gas processing facilities; LNG facilities; pipeline shore facilities, barge terminals and tanker port areas; coastal pipelines; coastal barging; and navigation channels.

Refer to Chapter 4.2.1.23.1.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.23.1 of the WPA 233/CPA 231 Supplemental EIS for a more detailed description of these infrastructure types. Impact-producing factors associated with a CPA proposed action that could affect land use and coastal infrastructure include, but are not limited to, gas processing facilities, pipeline landfalls, service bases, navigation channels, waste disposal facilities, oil spills, vessel collisions, and chemical/drilling-fluid spills. Impacts from these routine and accidental impact-producing factors are discussed above and in Chapters 4.2.1.23.1.2 and 4.2.1.23.1.3 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.23.1 of the WPA 233/CPA 231 Supplemental EIS. BOEM's staff continually monitors developments in the OCS onshore-related industries and will update analyses as new information becomes available.

Gas Processing Facilities

The majority of change is likely to occur from general, regional economic and demographic growth rather than from activities associated with current OCS and/or State offshore petroleum production or future planned OCS or State lease sales. BOEM's development scenarios consider demand from both current and future OCS and State leases. These scenarios project 0-1 new gas processing facilities to result from a CPA proposed action. However, this number is derived from the estimated demand for future processing capacity. Given current industry practice, it is likely that few (if any) new, greenfield gas processing facilities would actually be constructed along the CPA. Instead, it is likely that a large share (and possibly all) of any additional natural gas processing capacity that is needed in the industry would be developed at existing facilities through future investments in expansions and/or replacement of depreciated capital equipment. Also, these BOEM scenario projections are conservative; that is, they likely overestimate the additional capacity that would be required.

Over the past several years, there has been a substantial decrease in offshore natural gas production, partially as a result of increasing emphasis on onshore shale gas development, which is less expensive to produce and provides larger per-well production opportunities and reserve growth. Also, there has been a trend toward more efficient gas processing facilities with greater processing capacities (Dismukes, 2011a). For example, in Texas the average daily processing capacity per plant increased from 95 MMcf to 121 MMcf per day between 2004 and 2009. Louisiana, Mississippi, and Alabama also saw their per-plant capacity increase, with the average capacity per plant in Mississippi more than doubling from 262 MMcf per day to 568 MMcf per day (USDOE, Energy Information Administration, 2011a). While natural gas production on the OCS (shallow water) has been rapidly declining, deepwater gas production has been increasing, but not quickly enough to make up the difference. The U.S. Energy Information Administration's *Annual Energy Outlook 2013* forecasts that Gulf offshore natural gas production will decrease from 2.15 Tcf per day in 2012 to 1.89 Tcf per day in 2013 and to 1.79 Tcf per day in 2014 (USDOE, Energy Information Administration, 2013b). These production trends are driven by many factors, including price pressures arising from increasing onshore natural gas production (Humphries, 2013). Increasing onshore shale gas development, declining offshore gas production, and the increasing efficiency and capacity of existing gas processing facilities are trends that have combined to lower the need for new gas processing facilities along the Gulf Coast. In terms of both capacity and the number of plants, Texas and Louisiana accounted for nearly half of all U.S. capacity and plants (USDOE, Energy Information Administration, 2011b). Spare capacity at existing facilities should be sufficient to satisfy new gas production for many years, although there remains a slim chance that a new gas processing facility may be needed by the end of the 40-year life of a CPA proposed action (Dismukes, official communication, 2013b). Any additions to, or expansions of, current facilities would also support State oil and gas production and, should any occur, the land in the analysis area is sufficient to handle development. Thus, the results of OCS and State oil and gas activities are expected to minimally alter the current land use of the area.

Pipeline Landfalls

BOEM analyzes the potential for new pipeline landfalls to determine the potential impacts to wetlands and other coastal habitats. In **Chapter 3.1.2.1** of this Supplemental EIS, Chapter 3.1.2.1.6 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 3.1.2.1 of the WPA 233/CPA 231 Supplemental EIS, BOEM assumes that the majority of new Federal OCS pipelines would connect to the existing infrastructure in Federal and State waters and that very few would result in new pipeline landfalls. Therefore, BOEM projects up to one pipeline landfall for a CPA proposed action; however, it is generally unlikely that even one landfall would result from a CPA proposed action.

Service Bases/Ports

Service-base infrastructure supports offshore petroleum-related activities in both OCS and State waters. Any changes to offshore support infrastructure that occurs in the cumulative case are expected to be contained on available land. Service bases are industrial ports and are located in designated industrial parks designed with the intent to accommodate future oil and gas needs. Also, most of these are located in BOEM analysis areas that have strong industrial bases. Shore-based OCS and State servicing is expected to increase in the ports of Galveston, Texas; Port Fourchon, Louisiana; and Mobile, Alabama. There is sufficient land designated in commercial and industrial parks and adjacent to the Galveston port area. This would minimize disruption possible from port expansions to current residential and business use patterns.

In contrast, while Port Fourchon has land designated for future expansion, the port has a limited amount of waterfront land available and, because of surrounding wetlands, may face capacity constraints in the long term. Louisiana has the greatest rate of landloss in the Nation. A Louisiana State-sponsored study found that the "gradual erosion of Louisiana's coast may force the oil and gas industry to interrupt, postpone, or permanently delay the production and transportation of oil and gas products" (Richardson and Scott, 2004). It is unknown how current subsidence and erosion is impacting industry or whether industry is making plans to mitigate current or future impacts. BOEM will continue to monitor industry and its infrastructure footprint over time to document short- and long-term impacts of continued landloss. For a more detailed discussion on deltaic landloss, refer to **Chapter 4.1.1.4**. Port Fourchon serves as the primary support base for over 90 percent of existing deepwater projects, with 270 large supply vessels using the port's waterways each day (Greater Lafourche Port Commission, 2013). The OCS oil- and gas-related demands upon coastal infrastructure and land use tend to be geographically concentrated as compared with historic residential settlement within the region. For instance, Port Fourchon is the service base for over 90 percent of OCS deepwater production and serves as a conduit for 15-18 percent of the Nation's entire oil supply (Greater Lafourche Port Commission, 2011). As one of the most significant footprints within the OCS oil- and gas-related infrastructure corridor, Port Fourchon comprises only 2.7 developed square miles (7 km^2) within a close to 44,000-mi^2 (113,959-km^2) state. In Louisiana, there are 105 persons per square mile, and in Lafourche Parish (where Port Fourchon is located), there are 90 persons per square mile, both above the national average of 87 persons per square mile (USDOC, Census Bureau, 2010).

Navigation Canals

Chapter 3.1.2.1 of this Supplemental EIS, Chapter 3.1.2.1.8 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 3.1.2.1 of the WPA 233/CPA 231 Supplemental EIS discuss navigation channels along the Gulf Coast. Much of the traffic navigating these channels is unrelated to OCS activity, and the current system of navigation channels in the northern GOM is projected to be adequate for accommodating any additional traffic generated by a CPA proposed action. The Gulf-to-port channels and the Gulf Intracoastal Waterway that support prospective OCS ports are generally deep and wide enough to handle OCS oil- and gas-related traffic and are maintained by regular dredging if funding is available (Figure 3-7 of the 2012-2017 WPA/CPA Multisale EIS). All single lease sales contribute to the demand for offshore supply/service vessel support; hence, they also contribute to the vessel traffic that moves in and out of support facilities. Therefore, a CPA proposed action is likely to contribute to the continued need for maintenance dredging of existing navigation channels. However, no new navigation channels are expected to be dredged as a result of a CPA proposed action because the existing system of navigation channels is projected to be adequate to allow proper accommodation for vessel traffic that will occur as a result of a CPA proposed action.

Transportation

There is increasing demand to transport crude oil from Canadian and U.S. shale plays locations and send it by barge to Gulf Coast refineries. Scheduled to have opened in the second quarter of 2013 is the new Gulf Gateway Terminal, a crude oil destination terminal located at the Port of New Orleans. The terminal's unloading capacity is designed to handle one unit train per day and to be equipped to transfer up to 10,000 bbl per hour directly into barges or into tanks with 103,000 bbl of usable storage (Gulf Gateway Terminal, 2013).

Louisiana Highway 1 (LA Hwy 1) is the only highway connecting Port Fourchon with the rest of Louisiana. This two-lane highway is surrounded by marshland and has been prone to extreme flooding over the years, jeopardizing critical access to Port Fourchon, which has up to 1,200 trucks travelling in and out of the port each day (Greater Lafourche Port Commission, 2013). Currently, LA Hwy 1 is closed an average of 3.5 days annually due to inundation. However, within 15 years, NOAA anticipates that the at-grade portions of LA Hwy 1 will be inundated by tides an average of 30 times annually, even in the absence of extreme weather. Because of Port Fourchon's significance to the national, State, and local oil industry, the U.S. Department of Homeland Security, in July 2011, estimated that "a closure of 90 days could reduce national gross domestic product by $7.8 billion" (LA 1 Coalition, 2013). While, in the absence of planned expansions, LA Hwy 1 would not be able to handle future OCS and State activities, a multiphase LA Hwy 1 improvement project is currently underway. On July 8, 2009, the new LA Hwy 1 fixed-span toll bridge over Bayou Lafourche connecting Port Fourchon and Leeville, Louisiana, was opened and marks partial completion of the first phase of improvements to LA Hwy 1 (*Toll Roads News*, 2009). A large portion of the tolls collected will be paid by transportation activities associated with OCS oil- and gas-related activities. The remaining portion of Phase 1 construction, a two-lane elevated highway from the bridge to Port Fourchon, was completed in 2011. There are continuing efforts to get Federal funding to construct Phase 2 of the project—an elevated highway from the Golden Meadow floodgates to Leeville, Louisiana (Wilson, 2012).

The South Lafourche Leonard Miller Jr. Airport opened a partial parallel taxiway, and the Port Commission has plans to extend it to full length. In the past several years, $20 million has been invested in the airport for improvements that include the paving of airport roadways, runway expansion and overlay, installation of fuel tanks, and construction of an extra-large hangar. As a result of recent improvements, the airport is showing growth. Between 2012 and 2013, total aircraft operations at the South Lafourche Airport were the highest in airport history, exceeding 20,000 aircrafts (Greater Lafourche Port Commission, 2014).

If the service base expansion occurs in the cumulative case at the port of Galveston, Texas, or Mobile, Alabama, this expansion would occur in areas that are already industrialized and would have little effect on land use and infrastructure. This is also true for Port Fourchon, Louisiana, although, in the cumulative case, expansion of this service base may eventually be constrained by surrounding wetlands. Limited highway access and airport capacity could also constrain service base expansion at Port Fourchon in the cumulative case. However, ongoing and planned improvement projects make this unlikely.

Waste Disposal Facilities

The OCS waste disposal is discussed above and in **Chapter 3.1.2.2** of this Supplemental EIS, Chapters 4.2.1.23.1.1 and 3.1.2.2 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.23 of the WPA 233/CPA 231 Supplemental EIS. The scenario analysis concluded that no new solid-waste facilities would be built as a result of a single lease sale. Focused scenario analysis research into onshore waste disposal further supports the conclusion that existing solid-waste disposal infrastructure is adequate to support both existing and projected offshore oil and gas drilling and production needs (Dismukes et al., 2007).

Oil Spills and Chemical/Drilling Fluid Spills

Oil spills may be associated with exploration, production, or transportation activities that result from a CPA proposed action. A detailed risk analysis of offshore oil spills ranging from <1,000 bbl to ≥1,000 bbl and coastal spills associated with a WPA proposed action is provided in **Chapters 3.2.1.5**, **3.2.1.6, and 3.2.1.7** of this Supplemental EIS and Chapters 3.2.1.5, 3.2.1.6, and 3.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The mean number and sizes of spills estimated to occur in OCS offshore waters from an accident related to rig/platform and pipeline activities supporting a CPA proposed action are also presented in Table 3-12 of the 2012-2017 WPA/CPA Multisale EIS. Accidental spills as a result of a low-probability catastrophic event are discussed in **Appendix B**.

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a CPA proposed action. **Chapter 3.2.5** of this Supplemental EIS and Chapter 3.2.5 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS provide a detailed discussion of chemical and drilling-fluid spills. Each year, between 5 and 15 chemical spills are expected to occur; most of these are ≤50 bbl in size. Large spills are much less frequent. For example, from 1964 to 2005, only two chemical spills ≥1,000 bbl occurred. Even though additional production chemicals are needed in deepwater operations where hydrate formation is a possibility, spill volumes are expected to remain stable because of advances in subsea processing.

Non-OCS Oil- and Gas-Related Impacts

For a CPA proposed action, the primary region of geographic influence is coastal Texas, Louisiana, Mississippi, and Alabama. Land-use patterns vary greatly by region, reflecting differences in soils, climate, topography, and patterns of population settlement. Land-use changes will largely depend upon local zoning and economic trends. Mississippi and Louisiana are located in what the U.S. Department of Agriculture's Economic Research Service calls the Delta farm production region, while Alabama is located in the Southeast farm production region and Texas is located in the Southern Plain region (Lubowski et al., 2006). The Economic Research Service conducts land-use inventories based on available land use data obtained from surveys conducted both by the Economic Research Service and predecessor agencies. The following sections are divided into those land use categories and other non-OCS oil- and gas-related, impact-producing factors including the following: (1) State oil and gas activities; (2) agriculture; (3) forest, parks, and special use areas; (4) urban areas; (5) miscellaneous areas; (6) inland navigable waterways and ports; and (7) natural processes.

State Oil and Gas Activities

Effects of State oil- and gas-related activities are expected to be similar to the effects from OCS oil- and gas-related activities. Over the past several years, there has been a substantial decrease in offshore natural gas production, partially as a result of increasing emphasis on onshore shale gas development, which is less expensive to produce and which provides larger per well production opportunities and reserve growth. As described in **Chapter 3.1.2.1** of this Supplemental EIS and Chapter 3.1.2.1 of the 2012-2017 WPA/CPA Multisale EIS and the WPA 233/CPA 231 Supplemental EIS, onshore unconventional natural gas production has increased to the point that existing Gulf Coast LNG facilities are seeking to export natural gas to foreign consumers. In 2011, Cheniere's Sabine Pass facility in Louisiana received approval from DOE to export to any country in the world (Helman, 2013; USDOE, Federal Energy Regulatory Commission, 2013). Seventeen additional project sponsors have applied to

DOE for authorization to export domestically produced LNG to free trade agreement and non-free trade agreement countries. BOEM will continue to monitor future development of new LNG export facilities, but these should not on their own represent a significant development or change in land use.

Agriculture

Of the over 400,000 mi^2 (1,035,995 km^2) comprising these coastal states, 18 percent of the total land area is covered in cropland, which includes cropland harvested, crop failure, cultivated summer fallow, cropland used only for pasture, and idle cropland. Texas and Mississippi have the highest percentages of cropland, with 20 percent and 19 percent of each respective State's total land being used for cropland. Texas leads the Nation in cattle, cotton, hay, sheep, and wool (State of Texas, Dept. of Agriculture, 2013). Texas also leads the Nation in the number of farms and ranches, with 247,500 farms and ranches covering 130.4 million ac (52.8 million ha). For all four coastal states, 42 percent of the total land area is used for grassland pasture and range, with Texas devoting 61 percent of close to 262,000 mi^2 (679,095 km^2) for grassland pasture and range. Agriculture places many demands on the environment and produces impacts that include, but are not limited to, habitat fragmentation, pesticide and nutrient runoff, competing urban and agricultural water needs, changes to watershed hydrology, and changes in soil quality. Both State and Federal entities regulate various farming and ranching practices through laws such as the Clean Water Act, which establishes pollutant standards for many of the inputs used in conventional farming methods.

Forest, Parks, and Special-Use Areas

Forest land, which the U.S. Forest Service defines as land at least 10 percent stocked by trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated, makes up 28 percent of the total land area in these four coastal states. Alabama has the most forest use land, with 70 percent of the State's 53,868 mi^2 (139,517 km^2) covered in forest, followed by Mississippi with 65 percent of its total land area covered in forest. From the Gulf Coast Flatwoods to the Upper Coastal Plains, forest resources abound in Mississippi. Forest resources represent the State's largest single land use, covering more than 19.8 million ac (8.0 million ha) (Mississippi Forestry Commission, 2009). Rural lands, including privately owned forest, total 144 million ac (58 million ha), 86 percent of the Texas's total land area (State of Texas, Dept. of Agriculture, 2013). Forest use land includes timberland and reserved forest land, but it excludes forest land in parks, wildlife areas, and similar special purpose uses. Special-use areas (which include areas in highway, road, and railroad rights-of-way and airports; Federal and State parks, wilderness areas, and wildlife refuges; and national defense and industrial areas) make up 4 percent of the total land area for these four coastal states. Louisiana has the highest percentage of special-use area, with 7 percent of the land used for special-use purposes (Lubowski, et al., 2006). Texas, for instance, has 2 national parks and well over 100 State parks, national parks, and historic sites. Texas has 15 military bases throughout the state, Louisiana has 4 military bases, and Mississippi and Alabama each have 5 military bases (MilitaryBases.com, 2013a and b). The U.S. Congress decides when and where a military base will be established, but regardless of the branch of military, the new site and its associated environmental impacts would be subject to NEPA.

Texas has more than 10,000 mi (16,093 km) of railroad tracks, more than any other state. Those tracks are owned or operated by Union Pacific Railroad (6,408 mi; 10,313 km), the Burlington Northern/Santa Fe Railway (4,645 mi; 7,475 km), and the Kansas City Southern Railway (379 mi; 610 km). Also, the Texas State highway system consists of about 79,696 centerline miles (miles traveled in a one-way direction regardless of the number of lanes) of road and carries about 74 percent of the State's vehicular traffic. Included are 28,374 mi (45,664 km) of U.S. and State highways, carrying 36 percent of traffic (including 22 centerline miles of toll roads); 40,988 mi (65,967 km) of farm-to-market roads, carrying 11 percent of traffic; 9,953 mi (16,018 km) of interstate highways and frontage roads, carrying 26 percent of traffic; and 339 mi (546 km) of parks and recreation roads, carrying less than 1 percent of traffic. An additional 65 centerline miles of toll roads are under construction (State of Texas, Comptroller of Public Accounts, 2013).

Louisiana's highway network is the 32nd largest in the Nation, with the State highway system the 11th largest. The network is comprised of over 60,000 mi (96,561 km) and more than 13,000 bridges under the jurisdiction of Federal, State, and local governments and entities. The 27.4 percent of highway network centerline mileage that are State-owned places Louisiana 10th nationally, while the 30 percent of total highway network lane mileage that are State-owned places Louisiana 11th (State of Louisiana, Dept. of Transportation and Development, 2013). The network typically handles just under 41 billion mi (66 billion km) traveled annually. Louisiana also has 2,656 mi (4,274 km) of Class I railroad trackage and 2,823 mi (4,543 km) of inland waterways (State of Louisiana, Dept. of Transportation and Development, 2013). Five interstate highways converge in Alabama, allowing goods to be shipped to major markets. The I-22 is planned to be completed by 2014, making this the sixth interstate in Alabama (Economic Development Partnership of Alabama, 2013). The impacts of transportation corridors include noise, air pollution, and potential loss of living quality. Wildlife and plants suffer from habitat destruction and various forms of pollution. Ecosystems suffer fragmentation with habitats, and biomes that had worked in cohesion are separated. Transportation projects may also necessitate the draining or contamination of wetlands, crucial habitat for many species and important for flood control and filtering and cleaning water (USEPA, 1994). As a large-scale infrastructure project with potential environmental impacts, any new highway or rail corridor would be subject to Federal NEPA requirements as well as local and State regulatory scrutiny.

Urban Areas

Census urban areas include densely populated areas with at least 50,000 people (“urbanized areas”) and densely populated areas with 2,500-50,000 people (“urban clusters”). Included in the Census urban area definition are residential areas and concentrations of nonresidential urban areas such as commercial, industrial, and institutional land; office areas; urban streets and roads; major airports; urban parks and recreational areas; and other land within urban defined areas. The total urban land area for all four states is just 3 percent of the total land area, with Louisiana and Alabama tied for the highest percentage of urban areas, with 4 percent of each state being utilized for high population areas. Development takes the place of natural ecosystems and fragments habitat. It also influences decisions people make about how to get around and determines how much people must travel to meet daily needs. These mobility and travel decisions have indirect effects on human health and the natural environment by affecting air and water pollution levels. Impacts of urbanization include habitat fragmentation, reduced water and air qualities, and the urban heat island impact. On the other hand, residents of cities live in smaller homes and drive less because of the close proximity of amenities. Future trends in urban land use will be largely determined by economics, demographic shifts, local ordinances, and zoning (USEPA, 2013c).

Miscellaneous Areas

The final land use category according to the Economic Research Service, “Miscellaneous,” includes industrial and commercial sites in rural areas, cemeteries, golf courses, mining areas, quarry sites, marshes, swamps, sand dunes, bare rocks, deserts, tundra, rural residential, and other unclassified land. For Alabama, Mississippi, and Texas, 4 percent of land use is classified as miscellaneous; however, in Louisiana, 16 percent of land use is classified as miscellaneous. Louisiana contains 40-45 percent of the wetlands found in the lower states within its 195,000-mi^2 (505,048-km^2) footprint (USDOI, GS, 2012b).

Inland Navigable Waterways and Ports

Coastal states with inland navigable waterways and direct access to the Gulf of Mexico are uniquely positioned to benefit from international trade and facilitate domestic trade. The Ports of South Louisiana and Houston rank 12th and 13th, respectively, in total trade for all world ports and 1st and 2nd, respectively, for American ports (American Association of Port Authorities, 2011). With direct access to the Mississippi River and its system of inland rivers, the Port of South Louisiana averages 223 million metric tons per year. In Louisiana, there are 2,823 mi (4,543 km) of inland waterways (State of Louisiana, Dept. of Transportation and Development, 2013). Alabama’s water corridors connect to over 15,000 mi (24,140 km) of inland waterways in 23 states (Economic Development Partnership of Alabama, 2013). The Gulf Intracoastal Waterway runs 1,050 mi (1,690 km), connecting Gulf ports from Carrabelle, Florida, to Brownsville, Texas. In Texas alone, the waterway extends 423 mi (681 km). The Port of Houston handled 215 million metric tons in total cargo in 2011 (American Association of Port Authorities, 2011). The primary issue facing ports and inland navigable waterways is availability of funds and dredge vessels to maintain navigable depths and widths. The Harbor Maintenance Tax, established in 1986, is an ad valorem tax paid on the value of imports entering the U.S. on domestic cargo. Appropriations for the Harbor Maintenance Tax Fund, which are primarily used by COE for maintenance dredging, dredged material disposal areas, jetties and breakwaters, have lagged behind revenues (Ojard, 2013). While industry continues to plan for improvements and set aside funding, Congress has not appropriated funds to meet the demand for repairs and improvements, which have resulted in channels not being maintained to their constructed depths and widths. The America Society of Civil Engineers rated inland waterways with a D+ (poor) and gave ports a C (mediocre) in its 2013 report card (American Society of Civil Engineers, 2013). The Big River Coalition completed a study in 2013, which looked at the economic impact of dredging the Mississippi River to deeper depths. It found that for every 1,000 tons of cargo gained due to the deepening, the local economy will gain $14,691 in spending on ship services (e.g., loading, unloading, freight forwarding, dockage, etc.); inland transportation; and increased business for port users, mostly manufacturing firms. This gain in direct spending creates additional impacts in the local economy in secondary spending, sometimes referred to as the “ripple effect,” total spending (direct plus secondary spending), earnings of affected workers, jobs, and tax revenues for local, State, and Federal governments (Big River Coalition, 2013).

The U.S. Energy Sector has long prepared for all hazards, but natural disasters have traditionally been a key focus of sector efforts. The National Infrastructure Protection Plan, a comprehensive risk management framework that defines critical infrastructure protection roles and responsibilities for all levels of government, private industry, and other sector partners has evolved to identify and prepare other hazards that include terrorism (domestic and international), cyber security, and pandemics (USDHS, 2010). The *Energy Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan* details how the National Infrastructure Protection Plan risk management framework is implemented within the context of the unique characteristics and risk landscape of the sector (USDHS, 2010). Each Sector-Specific Agency develops a sector-specific plan through a coordinated effort involving its public and private sector partners. The DOE is designated as the Sector-Specific Agency for the Energy Sector. The energy infrastructure provides essential fuel to all of the other critical infrastructures, and in turn depends on the Nation’s transportation, information technology, communications, finance, and government infrastructures. Over time, cyber/information technology dependencies have increased. For example, electricity and natural gas suppliers rely heavily on data collection systems to ensure accurate billing. Energy control systems and the information and communications technologies on which they rely play a key role in the North American energy infrastructure. Energy infrastructure resilience is defined as the ability to reduce the magnitude and/or duration of disruptive events. The resilience of an infrastructure or enterprise depends on its ability to anticipate, absorb, adapt to, and/or rapidly recover from a disruptive event. The DOE, in cooperation with other Federal agencies, State and local governments, and sector partners, has undertaken programs to assess the risks of key energy infrastructure assets and to provide technology, tools, and expertise to Federal, State, local, Tribal, and territorial entities, and to public and private owners and operators of critical infrastructure. These programs are designed to assist all entities within the energy infrastructure in securing systems against physical and cyber attacks.

Natural Processes

A U.S. Geological Survey study published in spring 2013, *Economic Vulnerability to Sea-Level Rise along the Northern U.S. Gulf Coast* (Thatcher et al., 2013), applied a Coastal Economic Vulnerability Index (CEVI) to the northern Gulf coastal region in order to measure economic vulnerability to sea-level rise. Coastal landloss in Louisiana is an ongoing threat to the people and industry of that region—Louisiana has the greatest rate of landloss in the Nation. Louisiana contains 40-45 percent of the wetlands found in the lower states within its 195,000-mi^2 (505,048-km^2) footprint (USDOI, GS, 2012b). Louisiana also has the greatest rate of landloss in the Nation. The U.S. Geological Survey projects that coastal Louisiana has undergone a net change in land area of about 1,883 mi^2 (4,897 km^2) from 1932 to 2010. Within an area, the presence of a concentration of economically valuable infrastructure combined with physical vulnerability to inundation from sea-level rise resulted in the highest vulnerability rankings (CEVI score). The highest average CEVI score in the Gulf coastal region appeared in Lafourche Parish, Louisiana, where there is an extensive amount of valuable infrastructure related to the oil and gas industry, along with high relative sea-level rise rates and high coastal erosion rates (Thatcher, et al, 2013). For a more detailed discussion of this study and how it relates to environmental justice communities, refer to **Chapter 4.1.1.23.4** of this Supplemental EIS, Chapter 4.2.1.23.4 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.23.4 of the WPA 233/CPA 231 Supplemental EIS. A Louisiana State-sponsored study found that the "gradual erosion of Louisiana's coast may force the oil and gas industry to interrupt, postpone, or permanently delay the production and transportation of oil and gas products" (Richardson and Scott, 2004). It is unknown how current subsidence and erosion is impacting industry or whether industry is making plans to mitigate current or future impacts. BOEM will continue to monitor industry and its infrastructure footprint over time to document short- and long-term impacts of continued landloss. For a more detailed discussion on deltaic landloss, refer to **Chapter 4.1.1.4** of this Supplemental EIS, Chapter 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.4 of the WPA 233/CPA 231 Supplemental EIS.

While coastal infrastructure is subject to the impacts of coastal landloss and routine tropical storm activity, there is still considerable investment to expand and improve existing infrastructure. In June 2013, Governor Bobby Jindal of Louisiana signed Senate Bill 122, which modified the Investor Tax Credit and the Import-Export Tax Credit. The new credits now include projects like warehousing and storage, port operations, marine cargo handling, ship building and repairs, and oil and gas activities (State of Louisiana, Office of Governor, 2013). Additionally, the decision criteria for the State of Louisiana's 5-year coastal restoration planning document places a higher value on collections of risk reduction and restoration projects that improve coastal conditions for oil and gas infrastructure and increase the resilience of coastal communities that support the industry. The criterion also puts a higher value on projects that benefit the navigation industry and places a lower value on projects that impede navigation (State of Louisiana, Coastal Protection and Restoration Authority, 2012). Meanwhile, Texas experiences an overall loss of almost 6,000 ac (2,428 ha) of tidal and nontidal wetlands per year (State of Texas, General Lands Office, 2010). The Texas Coastal Erosion Planning and Response Act Program, which is administered by the Texas General Land Office, oversees restoration projects throughout the state. Restoration plans also focus on mitigating the impacts of tropical storms and land subsidence. Land-surface subsidence, or land subsidence, in areas including Harris County, Texas, which encompasses much of the Houston area, has been occurring for decades. Land subsidence has increased the frequency and extent of flooding, damaged buildings, and transportation infrastructure (Kasmarek et al., 2009). In addition to public efforts, private industry has teamed up with nongovernment organizations like the Nature Conservancy to mitigate risks from storms and flooding through small-scale restoration projects near private infrastructure. For instance, the Dow Chemical Company Collaboration partnered with The Nature Conservancy to evaluate green infrastructure solutions (e.g., protecting or restoring marshes, oyster reefs, etc.) alongside gray infrastructure solutions in their coastal hazard mitigation planning for their Freeport, Texas, facilities (Dow Chemical Company Collaboration, 2011).

Summary and Conclusion

Activities relating to the OCS Program and State oil and gas production are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks to accommodate future growth in oil and gas businesses. BOEM projects 0-1 new gas processing facilities and 0-1 new pipeline landfalls for a CPA proposed action, although this is a conservative estimate and the number is much closer to zero than to one. If a new gas processing facility or pipeline landfall were to occur, it would likely be toward the end of the 40-year analysis period (Dismukes, official communication 2011b). There may be a new increased demand for waste disposal services as a result of a CPA proposed action. Any service base expansion in the cumulative case would be limited, would occur on lands designated for such purposes, and would have minimal effects on land use and infrastructure. However, in the cumulative case, it is possible that Port Fourchon expansions may eventually be constrained by surrounding wetlands. Based on the available information and current BOEM scenario projections, the cumulative impacts on land use and coastal infrastructure from OCS oil- and gas-related activities are expected to be minor. Therefore, the incremental contribution of a CPA proposed action to the cumulative impacts on land use and coastal infrastructure is also expected to be minor.

The coastal infrastructure supporting a CPA proposed action represents only a small portion of the coastal land and infrastructure throughout the CPA and Gulf of Mexico, and little change is expected to occur due to changing agricultural and extractive (e.g., lumbering and petroleum) uses of onshore land. Many non-OCS oil- and gas-related factors contribute substantially to the cumulative impacts to land use and coastal infrastructure, including housing and other residential developments; the development of private and publicly owned recreational facilities; the construction and maintenance of industrial facilities and transportation systems; urbanization; city planning and zoning; changes to public facilities such as water, sewer, educational, and health facilities; changes to military bases and reserves; changes in population density; changes in State and Federal land-use regulations; and changes in non-OCS oil- and gas-related demands for water transportation systems and ports. Given the overwhelming contribution of these non-OCS oil- and gas-related factors to the cumulative impacts on land use and coastal infrastructure and the small incremental contribution of a CPA proposed action, the cumulative impacts on land use and coastal infrastructure are also expected to be minor.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

Additional research was conducted to investigate the availability of recent information affecting land use and coastal infrastructure since publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. Various Internet sources were examined, including the websites of numerous Federal and State agencies (USDHS, Federal Emergency Management Agency; USDOC, Bureau of the Census; USDOC, NOAA; USDOE, Energy Information Administration; USDOT, Maritime Administration; USDOI, FWS; RestoreTheGulf.gov website; *Deepwater Horizon* Oil Spill Portal; USEPA; Louisiana Department of Environmental Quality; Louisiana Recovery Authority; Louisiana Office of Community Development; Mississippi Department of Environmental Quality; Alabama Department of Environmental Management; and the Florida Department of Environmental Protection). Further information was sought from other organizations, recently published journal articles, and trade publications such as The Greater Lafourche Port Commission, LA1 Coalition, The Oil Drum, Rigzone, Oil and Gas Journal, *Offshore* Magazine, TOLLROADS News, and *The Energy Journal*. This research revealed Sasol, Inc.'s plan to build a gas-to-liquids processing facility in Calcasieu Parish, Louisiana. This would be the first gas-to-liquids facility constructed in the United States. Plans call for an 18-month feasibility study to consider two development options, specifically, whether it will produce 2 million tons per year or 4 million tons per year (Troy, 2011). At present, BOEM believes that most of this gas will be sourced from onshore unconventional reserves rather than from OCS supplies. BOEM will continue to monitor future development of this new coastal infrastructure category (gas-to-liquids facilities), but this one proposed plan would not be expected to on its own represent a significant development or change in land use.

BOEM will continue to monitor these infrastructure effects as they evolve over time. Although this information on infrastructure effects is evolving and may be relevant to reasonably foreseeable significant impacts to the Gulf economy, this information would not be essential to a reasoned choice among the alternatives because regardless of whether the decisionmaker chooses to hold a proposed lease sale under the Action alternatives or chooses the No Action alternative, there remain many preexisting OCS leases in the CPA that would continue to support the economy. A CPA proposed action would not be expected to, on its own, result in significant impacts. The incomplete or unavailable information, even if available, would not be expected to change these conclusions.

A U.S. Geological Survey study published in spring 2013, *Economic Vulnerability to Sea-Level Rise along the Northern U.S. Gulf Coast* (Thatcher et al., 2013), applied a CEVI to the northern Gulf coastal region in order to measure economic vulnerability to sea-level rise. Coastal landloss in Louisiana is an ongoing threat to the people and industry of that region. Louisiana has the greatest rate of landloss in the Nation. The U.S. Geological Survey projects that coastal Louisiana has undergone a net loss in land area of about 1,883 mi^2 (4,897 km^2) from 1932 to 2010. Within an area, the presence of a concentration of economically valuable infrastructure combined with physical vulnerability to inundation from sea-level rise resulted in the highest vulnerability rankings (CEVI score). The highest average CEVI score in the Gulf coastal region appeared in Lafourche Parish, Louisiana, where there is an extensive amount of valuable infrastructure related to the oil and gas industry, along with high relative sea-level rise rates and high coastal erosion rates (Thatcher et al, 2013). For a more detailed discussion of this study and how it relates to environmental justice communities, refer to **Chapter 4.1.1.23.4** of this Supplemental EIS, Chapter 4.2.1.23.4 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.23.4 of the WPA 233/CPA 231 Supplemental EIS.

While coastal infrastructure is subject to the impacts of coastal landloss and routine tropical storm activity, there is still considerable investment to expand and improve existing infrastructure. In June 2013, Governor Bobby Jindal of Louisiana signed Senate Bill 122, which modified the Investor Tax

Credit and the Import-Export Tax Credit. The new credits now include projects like warehousing and storage, port operations, marine cargo handling, ship building and repairs, and oil and gas activities (State of Louisiana, Office of Governor, 2013). Additionally, the decision criteria for the State of Louisiana's 5-year coastal restoration planning document places a higher value on collections of risk reduction and restoration projects that improve coastal conditions for oil and gas infrastructure and increase the resilience of coastal communities that support the industry. The criteria also put a higher value on projects that benefit the navigation industry and places a lower value on projects that impede navigation (State of Louisiana, CPRA, 2012). In addition to public efforts, private industry has teamed up with nongovernment organizations like The Nature Conservancy to mitigate risks from storms and flooding through small-scale restoration projects near private infrastructure. For instance, the Dow Chemical Company Collaboration partnered with The Nature Conservancy to evaluate green infrastructure solutions (e.g., protecting or restoring marshes, oyster reefs, etc.) alongside gray infrastructure solutions in their coastal hazard mitigation planning for their Freeport, Texas, facilities (Dow Chemical Company Collaboration, 2011).

The Gulf of Mexico OCS exploration and production industry has more or less recovered from the effects of the *Deepwater Horizon* explosion, oil spill, and response, including the related drilling suspensions and the development of needed adaptations to new Federal requirements for drilling safety. In 2012, Federal regulators issued the most permits for deepwater drilling in the Gulf of Mexico since 2007, with BSEE approving 520 deepwater well permit applications in 2012 alone (Dupre, 2013; USDOI, BSEE, 2013b). If drilling activity continues with its current upward trajectory, there may be new increased demand for waste disposal services as a result of a CPA proposed action. Current capacity, however, should be able to accommodate any increased demand. The Argonne National Laboratory reported that there were 46 waste management facilities that serviced the oil and gas industry along the GOM, with 18 in Louisiana and 18 in Texas, as well as numerous salt caverns used for oil and gas waste disposal scattered throughout Texas (Dismukes, official communication, 2013b). There are also facilities equipped to recycle some of the wastes associated with exploration and production, and industry and universities are also working on technologies to utilize exploration and production wastes, such as drill cuttings, as inputs for construction materials (Saunders, 2012).

As described in **Chapter 3.1.2.1** of this Supplemental EIS and Chapter 3.1.2.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, onshore unconventional natural gas production has increased to the point that existing Gulf Coast LNG facilities are seeking to export natural gas to foreign consumers. In 2011, Cheniere's Sabine Pass, Louisiana, facility received approval from DOE to export to any country in the world (Helman, 2013; USDOE, Federal Energy Regulatory Commission, 2013). Seventeen additional project sponsors have applied to DOE for authorization to export domestically produced LNG to free trade agreement and non-free trade agreement countries. BOEM will continue to monitor future development of new LNG export facilities, but these should not on their own represent a significant development or change in land use.

4.1.1.23.2. Demographics

BOEM has reexamined the analysis for demographics presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for demographics presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapter 4.2.1.23.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.2 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since the publication of these documents is presented below. A detailed description of demographics can be found in Chapter 4.2.1.23.2.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.2 of the WPA 233/CPA 231 Supplemental EIS.

Impacts of Routine and Accidental Events

A detailed impact analysis of the routine impacts of proposed CPA Lease Sales 235, 241, and 247 on demographics can be found in Chapter 4.2.1.23.2.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.2 of the WPA 233/CPA 231 Supplemental EIS.

In general, impact producing factors that cause employment impacts, such as exploration and delineation activities, development and production activities, and coastal infrastructure development, can have some impacts on the demographic characteristics of a particular area. However, routine activities associated with a CPA proposed action are projected to minimally affect the demography of the analysis area. The projected impacts to population arising from a lease sale are calculated by multiplying the employment estimates from the mathematical model MAG-PLAN by an estimate of the number of members in a typical family. The projected population increases arising from a lease sale are then divided by the population forecasts in Woods and Poole, Inc. (2013), which yields the percentage impacts to population of a lease sale. Population impacts from a CPA proposed action are projected to be minimal (<1% of the total population) for all Economic Impact Areas (EIA's) in the Gulf of Mexico region.

A detailed analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on demographics can be found in Chapter 4.2.1.23.2.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.2 of the WPA 233/CPA 231 Supplemental EIS.

Accidental events associated with a CPA proposed action, such as low to moderate scale oil or chemical spills, blowouts, and vessel collisions, would likely have no effects on the long-term demographic characteristics of the Gulf coastal communities. This is because accidental events typically cause only short-term population movements as individuals seek employment related to the event or have their existing employment displaced during the event. For a detailed discussion on the employment and demographic impacts of a low-probability catastrophic spill, refer to **Appendix B**.

Summary and Conclusion

BOEM has reexamined the analysis for demographics presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for demographics presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because the new Woods and Poole data did not change much from what was presented in those documents. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

This section considers the combined effects of OCS oil- and gas-related and non-OCS oil- and gas-related factors on demographics in the Gulf of Mexico. The demographic characteristics of any area include the distribution of population, age, gender, ethnicity, employment, and earnings in that area. The OCS oil- and gas-related factors that could impact the demographics of any area consist of routine activities and accidental events arising from prior, current, and future OCS lease sales. The impacts of routine activities and accidental events on demographics are discussed above; the impacts of a low-probability catastrophic oil spill are discussed in **Appendix B**. There are numerous non-OCS oil- and gas-related factors that could impact demographics, including fluctuations in workforce, net migration, relative income, oil and gas activity in State waters, and offshore liquefied natural gas activity. Most approaches to analyzing cumulative effects begin by assembling a list of projects and actions that will likely be associated with a CPA proposed action. 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 over a 40-year period. Instead, this analysis uses the economic and demographic projections from Woods & Poole Economics, Inc. (2013) as a reasonable approximation to define the contributions of other likely projects, actions, and trends to the cumulative case. These projections include population associated with the continuation of current patterns of OCS leasing activity as well as the continuation of trends in other industries important to the region.

OCS Oil- and Gas-Related Impacts

The projected impacts to population arising from the OCS Program are calculated by multiplying the employment estimates from the mathematical model MAG-PLAN by an estimate of the number of members in a typical family. The projected population increases arising from the OCS Program are then divided by the population forecasts in Woods and Poole, Inc. (2013), which yields the percentage impacts of the OCS Program. For more information about MAG-PLAN, refer to **Chapter 4.1.1.23.3** of this Supplemental EIS and Chapter 4.2.1.23.3.2 of the 2012-2017 WPA/CPA Multisale EIS. **Table 4-7** presents estimates of the population impacts of the OCS Program under the low-case and high-case exploration and development scenarios. These cumulative scenarios reflect activities that are expected to arise from prior, current, and future OCS lease sales. The cumulative projections reflect the positive contribution to population that will arise from increased employment arising from OCS oil and gas activities, as well as the positive impacts to population that will arise from maintaining current employment in OCS oil- and gas-related industries. The OCS Program is projected to have the greatest positive impacts on population in the following EIA's (the low-case and high-case percentage impacts are in parenthesis, respectively): LA-2 (3.3%, 5.1%); LA-3 (2.5%, 3.9%); LA-1 (2.2%, 3.6%); MS-1 (1.6%, 2.6%); TX-3 (1.5%, 2.2%); and AL-1 (1.3%, 2.2%). A CPA proposed action would represent a small fraction of these broader impacts.

A CPA proposed action would also incrementally contribute to the risk of oil spills that could arise from the OCS Program. However, oil spills typically cause only short-term population movements as individuals seek employment related to the event or have their existing employment displaced during the event.

Non-OCS Oil- and Gas-Related Impacts

Table 4-8 provides projections of the evolution of the total population in all EIA's in future years. These projections incorporate the impacts from all non-OCS oil- and gas-related sources, such as fluctuations in workforce, net migration, relative income, oil and gas activity in State waters, and offshore liquefied natural gas activity. In 2012, the total Gulf Coast population was 25.19 million. In 2012, the EIA's with the largest populations were TX-3 (6.44 million), FL-4 (6.36 million), and FL-3 (3.72 million). The EIA's with the smallest populations were LA-1 (349,640), MS-1 (489,210), and LA-2 (598,630). For all EIA's combined, it is expected that the total population will grow at a 1.3 percent rate between 2012 and 2051. The fastest population growth is expected in TX-3 (1.6%), LA-2 (1.4%), and TX-1 (1.4%); the slowest population growth is expected in LA-4 (0.5%) and MS-1 (0.6%). **Tables 4-9 through 4-21** provide projections of employment, income, wealth, business patterns, and racial composition for individual EIA's.

The racial and ethnic composition of the analysis area is influenced by many non-OCS oil- and gas-related sources, including settlement patterns and employment opportunities in various economic sectors. For example, those areas in Texas where Hispanics are the dominant group (i.e., EIA TX-1 where they represent 82% of the population) were also first settled by people from Mexico. By TX-3, the size of the African-American population increases, and there is a more diversified racial mix. In Louisiana, Mississippi, Alabama, and northern Florida (FL-1 and FL-2), African Americans outnumber Hispanics. A more detailed discussion of minority populations in the area can be found in **Chapter 4.1.1.23.4**. As discussed above, the impacts of a CPA proposed action to these projected demographic trends are expected to be minimal.

Summary and Conclusion

A CPA proposed action is projected to have an incremental contribution of less than 1 percent to the population level in any of the EIA's, in comparison to other factors influencing population growth, such as the status of the overall economy, fluctuations in workforce, net migration, and changes in income. Given both the low levels of population growth and industrial expansion associated with a CPA proposed action, it is expected that the baseline age and racial distribution pattern will continue through the analysis period.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

BOEM conducted a search of known data sources related to demographics and Internet resources. The primary source of new information is Woods & Poole Economics, Inc. (2013), which is an annual update of the data that were used in the WPA 233/CPA 231 Supplemental EIS. Woods & Poole Economics, Inc. (2013) provides projections of economic and demographic variables at the county level. **Table 4-8** provides projections of the evolution of the total population in all EIA's in future years. These projections assume the continuation of existing social, economic, and technological trends at the time of the forecast. In 2012, the total Gulf Coast population was 25.19 million. In 2012, the EIA's with the largest populations were TX-3 (6.44 million), FL-4 (6.36 million), and FL-3 (3.72 million). The EIA's with the smallest populations were LA-1 (349,640), MS-1 (489,210), and LA-2 (598,630). For all EIA's combined, it is expected that the total population will grow at a 1.3 percent rate through 2051. The fastest population growth is expected in TX-3 (1.6%), LA-2 (1.4%), and TX-1 (1.4%); the slowest population growth is expected in LA-4 (0.5%) and MS-1 (0.6%). **Tables 4-9 through 4-21** provide projections of employment, income, wealth, business patterns, and racial composition for individual EIA's. In general, the projections of these variables have not changed noticeably from the projections in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

4.1.1.23.3. Economic Factors

BOEM has reexamined the analysis for economic factors presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for economic factors presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapters 4.2.1.23.3.2 and 4.2.1.23.3.3 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.23.3 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below.

A detailed description of economic factors can be found in Chapter 4.2.1.23.3.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.3 of the WPA 233/CPA 231 Supplemental EIS.

Impacts of Routine and Accidental Events

A detailed impact analysis of the routine impacts of proposed CPA Lease Sales 235, 241, and 247 on economic factors can be found in Chapter 4.2.1.23.3.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.3 of the WPA 233/CPA 231 Supplemental EIS.

As a result of proposed CPA Lease Sales 235, 241, and 247, there would be only minor economic changes in the Texas, Louisiana, Mississippi, Alabama, and Florida EIS's. This is because the demand would be met primarily with the existing population and labor force. Most of the employment related to proposed CPA Lease Sales 235, 241, and 247 is expected to occur in Texas (primarily in the EIA TX-3) and in the coastal areas of Louisiana. A CPA proposed action, irrespective of whether one analyzes the high-case or low-case production scenario, would not cause employment effects >1 percent in any EIA along the Gulf Coast.

A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on economic factors can be found in Chapter 4.2.1.23.3.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.3 of the WPA 233/CPA 231 Supplemental EIS.

An oil spill can cause a number of disruptions to local economies. Many of these effects are due to industries that depend on damaged resources. However, the impacts of an oil spill can be somewhat broader if companies further along industry supply chains are affected. These effects depend on issues such as the duration, methods, and logistics of the cleanup operations and the responses of policymakers to a spill. However, the impacts of small-to medium-sized spills should be localized and temporary.

Summary and Conclusion

BOEM has reexamined the analysis for economic factors presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for economic factors presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because the new information was roughly in line with prior expectations. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The cumulative impacts on economic factors will arise from the expected progression of the broader OCS Program, the expected progression of overall economic activity, the potential risks of oil spills, and the potential risks of natural events such as hurricanes.

OCS Oil- and Gas-Related Impacts

A CPA proposed action would contribute to the economic effects of the broader OCS Program. The OCS Program directly affects firms that are responsible for well drilling, equipment manufacturing, pipeline construction, and servicing OCS activities. The OCS oil- and gas-related activities also impact the suppliers to those firms, as well as firms that depend on consumer spending of oil and gas industry workers. These activities support employment (and the corresponding levels of population) in various areas in the Gulf of Mexico region. In order to estimate the scale of these effects, BOEM has developed the mathematical model MAG-PLAN, which is a two-stage model. The first stage estimates the levels of spending in various industries that arise from a particular scenario for oil and gas exploration and development; these scenarios include estimates of activities such as drilling, platform installations, and structure removals. These estimates arise from a detailed analysis of the numerous activities that are needed to directly support OCS oil- and gas-related operations. The second stage estimates the impacts of oil and gas industry spending on the broader economies along the Gulf Coast. First, direct OCS oil- and gas-related industry spending will support activities further down the supply chain; these are referred to as "indirect" economic impacts. In addition, the incomes of employees along the OCS industry's supply chain will support consumer spending throughout the economy; these are referred to as "induced" economic impacts. These indirect and induced effects are estimated using the widely used economic modeling software IMPLAN. In particular, MAG-PLAN uses IMPLAN "multipliers" to compute how direct OCS spending circulates within the economy and translates into additional indirect and induced economic impacts. The MAG-PLAN has some limitations. For example, its employment estimates are not able to fully take into account the expected progression of the economy in future years. However, MAG-PLAN still provides reasonable estimates of the relative scale of the economic impacts of OCS activities. The initial version of MAG-PLAN is outlined in Manik et al. (2005). BOEM has made a number of adjustments to MAG-PLAN in recent years. For example, BOEM has incorporated the use of a number of new technologies, such as subsea systems and floating production, storage, and offloading system units, into MAG-PLAN. BOEM has also incorporated additional data regarding onshore support activities into the model. More information regarding the most recent version of MAG-PLAN can be found in Eastern Research Group, Inc. (2012).

Table 4-22 presents data on the peak levels of employment in EIA's that are forecasted to arise from the entire Gulf of Mexico OCS Program. The peak employment levels for the entire OCS industry are primarily felt in Louisiana and Texas (primarily in the EIA TX-3). The OCS activities will support 53,000 jobs in TX-3 in the peak employment year according to the low-production scenario and over 78,000 jobs in the high-production scenario. However, as can be seen in **Table 4-22**, the OCS industry will make up a larger fraction of the economy of south Louisiana. For example, in LA-2, under the high-case scenario, the OCS industry will support 3.5 percent of total employment, while in TX-3, the OCS industry will support 1.5 percent of total 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. BOEM does expect some employment will be met through in-migration; however, this level is projected to be small and localized. As discussed in **Chapter 4.1.1.23.3**, a CPA proposed action is expected to contribute less than 1 percent to the employment level in each of the EIA's.

Oil Spills

A CPA proposed action would contribute to the risk of an oil spill arising from the broader OCS Program. The impacts of low to moderate oil spills are discussed in Chapter 4.2.1.23.3.3 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.23.3 of the WPA 233/CPA 231 Supplemental EIS. The impacts of a low-probability catastrophic oil spill are discussed in **Appendix B**. In general, a CPA proposed action would only slightly increase the likelihood of oil spills.

Non-OCS Oil- and Gas-Related Impacts

Most approaches to analyzing cumulative effects begin by assembling a list of other likely projects and actions that would be included with a CPA 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 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 & Poole Economics, Inc. (2013) 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 and infrastructure development (refer to **Chapter 4.1.1.23.1**), as well as the continuation of trends in other industries important to the region. For example, these forecasts include the contributions of State oil and gas activities, renewable energy activities, coastal land use, tourism-related activities, and beach restoration projects using sand and gravel. **Table 4-23** provides projections of employment, income, wealth, and business patterns for individual EIA's; these data were obtained from the 2013 CEDDS data provided by Woods & Poole Economics, Inc. (2013). As discussed in the previous section, the OCS oil and gas industry comprises a modest percentage of the economies of most EIA's.

Hurricanes

The impacts of a CPA proposed action on economic factors should be viewed in light of the ongoing risk of hurricanes in the Gulf of Mexico. Hurricanes can cause impacts to the OCS oil and gas industry by shutting down production in the immediate vicinity. Hurricanes can also cause disruptions to the functioning of economies and, if severe enough, can cause labor migrations to occur. Finally, hurricanes can cause damage to a number of base resources on which local economies depend.

Summary and Conclusion

The cumulative impacts of a CPA proposed action would be determined by the expected path of the economy and by the expected progression of the OCS oil and gas industry in upcoming years. The expected path of the overall economy is projected using the data provided by Woods and Poole Economics, Inc. (2013). The expected economic impacts of the OCS oil and gas industry in upcoming years are estimated using the mathematical model MAG-PLAN. The cumulative impacts of a CPA proposed action to the economies along the Gulf Coast are expected to be relatively small.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

BOEM conducted a search of Internet sources and of known data sources regarding economic factors. A study report that describes the most recent updates to BOEM's economic model MAG-PLAN has become available (Eastern Research Group, 2012). This report describes the methods used to reflect developments in new technologies, to incorporate costs for major activities, to incorporate detailed onshore distribution data, and to estimate onshore distributions of industry sectors at different levels of granularity. The MAG-PLAN's estimates of the levels of employment impacts of lease sales are the same as was presented in the WPA 233/CPA 231 Supplemental EIS. Kaiser et al. (2013) provide additional information regarding the structures of the various components of the offshore drilling industry in the Gulf of Mexico. For example, this report describes the trends, major firms, and determinants of activity levels in both the drilling service market and the rig newbuild market.

Beaubouef (2013) and Dupre (2013) provide updates regarding the status of oil and gas exploration and development activities in the Gulf of Mexico. These reports find that exploration and development activities are increasing and that drilling has rebounded to levels seen prior to the *Deepwater Horizon* explosion, oil spill, and response. These reports also forecast that exploration and development activities will continue to increase in future years. IHS Petrodata (2013) finds that its jackup day rate index for the Gulf of Mexico increased from 417 in October 2012 to 535 in October 2013. Workboat.com (2013) finds that day rates for offshore supply boats less than 200 deadweight tons increased from $5,840 in September 2012 to $11,736 in September 2013, while day rates for offshore crewboats under 170 feet long increased from $3,410 in September 2012 to $5,180 in September 2013.

The U.S. Energy Information Administration has also released its *Annual Energy Outlook 2013* (USDOE, Energy Information Administration, 2013b). This report provides forecasts regarding a wide variety of issues related to energy markets. For example, this report provides forecasts of the levels of oil and gas production that will occur in Gulf offshore waters in future years. In its reference scenario, this report forecasts that Gulf offshore oil production will increase from 1.32 MMbbl per day in 2012 to 1.40 MMbbl per day in 2013 and 1.51 MMbbl per day in 2014. This report forecasts that Gulf offshore natural gas production will decrease from 2.15 Tcf per day in 2012 to 1.89 Tcf per day in 2013 and 1.79 Tcf per day in 2014. These production trends are driven by many factors, including price pressures arising from increasing onshore natural gas production (Humphries, 2013). Future production will also be influenced by a variety of factors that could affect oil and gas prices, such as the potential for increased energy production in Mexico that could arise from reforms of its energy sector (Hill, 2013).

The impacts of a proposed CPA lease sale and the OCS Program should be viewed in the context of overall economic conditions. In **Table 4-8**, data from Woods and Poole Economics, Inc. (2013) is used to generate forecasts of overall employment in EIA's during the life of activities that would arise from a proposed CPA lease sale. Woods and Poole Economics, Inc. (2013) is also used to forecast various demographic variables; refer to **Chapter 4.1.1.23.2** for more information regarding demographics.

There remains some incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on economic factors. This information relates to the ultimate economic effects of the *Deepwater Horizon* oil spill, as well to gradual changes that may be made to MAG-PLAN over time. Given the available data that have been released, as described in this chapter, BOEM believes that this incomplete or unavailable information is not essential to a reasoned choice among alternatives. This is because this information is not expected to significantly change BOEM's estimates of the routine, accidental, or cumulative impacts of a proposed CPA lease sale.

4.1.1.23.4. Environmental Justice

BOEM has reexamined the analysis for environmental justice presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. No new significant information was discovered that would alter the impact conclusion for environmental justice presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

The full analyses of the potential impacts of routine activities and accidental events associated with a CPA proposed action are presented in Chapters 4.2.1.23.4.2 and 4.2.1.23.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.4 of the WPA 233/CPA 231 Supplemental EIS. A CPA proposed action's incremental contribution to the cumulative impacts is presented below. Any new information that has become available since those documents were published is presented below. A detailed description of environmental justice can be found in Chapter 4.2.1.23.4.1

of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.4 of the WPA 233/CPA 231 Supplemental EIS.

The oil and gas industry and its associated support sectors are interlinked and widely distributed along the Gulf Coast. Offshore OCS oil- and gas-related industry operations within the CPA may utilize onshore facilities located within the WPA, CPA, or both planning areas. In accordance with NEPA and the Executive Orders, BOEM must provide opportunities for community input during the NEPA process. Minority and low-income populations are provided the same opportunities as other communities to engage in the decisionmaking process.

Impacts of Routine and Accidental Events

The following routine activities associated with proposed CPA Lease Sales 235, 241, and 247 could potentially affect environmental justice: potential infrastructure changes/expansions including fabrication yards, support bases, and onshore disposal sites for offshore waste; increased commuter and truck traffic; and employment changes and immigration. An analysis of the routine impacts of a CPA proposed action on environmental justice can be found in Chapter 4.2.1.23.4.2 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.4 of the WPA 233/CPA 231 Supplemental EIS.

Because of the existing extensive and widespread support system for OCS oil- and gas-related industry and the associated labor force, the effects of routine events related to a CPA proposed action are expected to be widely distributed and to have little impact. This is because a CPA proposed action is not expected to significantly change most of the existing conditions, such as traffic or the amount of infrastructure. Where such change might occur is impossible to predict but, in any case, it would be very limited. Because of Louisiana’s extensive oil-related support system, that State is likely to experience more employment effects related to a CPA proposed action than are the other coastal states, and because of the concentration of this system in Lafourche Parish, that parish is likely to experience the greatest benefits from employment benefits and burdens from traffic and infrastructure demand. Impacts related to a CPA proposed action on minority and low-income populations are expected to be primarily economic in nature and to have a limited but positive effect on low-income and minority populations because a CPA proposed action would contribute to the sustainability of current industry and related support services. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples adjacent to the OCS infrastructure (Chapter 4.2.1.23.4 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS) (Kaplan, et al., 2011), a CPA proposed action is not expected to have a disproportionate effect on these populations, even in Lafourche Parish.

Accidental events with impact-producing factors that may be associated with a CPA proposed action that could affect environmental justice include oil spills, vessel collisions, and chemical/drilling-fluid spills. These factors could affect environmental justice through direct exposure to oil, dispersants, degreasers, and other chemicals that can affect human health; decreased access to natural resources due to environmental damages, fisheries closures, or wildlife contamination; and proximity to onshore disposal sites used in support of oil and chemical spill cleanup efforts. A detailed impact analysis of the accidental impacts that may be associated with proposed CPA Lease Sales 235, 241, and 247 on environmental justice can be found in Chapter 4.2.1.23.4.3 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.23.4 of the WPA 233/CPA 231 Supplemental EIS.

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from a CPA proposed action. Low-income and minority populations might be more sensitive to oil spills in coastal waters than is the general population because of their dietary reliance on wild coastal resources, their reliance on these resources for other subsistence purposes such as sharing and bartering, their limited flexibility in substituting wild resources with purchased ones, and their likelihood of participating in cleanup efforts and other mitigating activities. Little is known about subsistence along the Gulf Coast, and BOEM is currently funding a study to better document subsistence in the region. BOEM’s subject-matter experts have utilized available, credible information for this analysis. Although most criteria related to environmental justice may not be essential to a reasoned choice among alternatives, subsistence impacts may be essential. Nevertheless, subsistence research is pending and outcomes will not be available within the timeline contemplated in the NEPA analysis of this Supplemental EIS. What credible information is available was applied using accepted methodologies. BOEM will continue to seek additional information as it becomes available and bases this analysis on the best information currently available. With the exception of a low-probability catastrophic accidental event, such as the *Deepwater Horizon* explosion, oil spill, and response, which is not reasonably foreseeable and not part of a CPA proposed action, the impacts of oil spills, vessel collisions, and chemical/drilling fluid spills are not likely to be of sufficient duration to have adverse and disproportionate long-term effects for low-income and minority communities in the analysis area.

An event like the *Deepwater Horizon* explosion, oil spill, and response, which is not reasonably foreseeable and not part of a CPA proposed action, potentially could have adverse and disproportionate health effects for low-income and minority populations in the analysis area; however, to date, there has been little concrete evidence that such effects have occurred (Brown et al., 2011; Dickey, 2012; King and Gibbons, 2011; Middlebrook et al., 2011; U.S. Dept. of Labor, OSHA, 2010a and 2010b), although there is some dispute in the scientific community about proper risk assessment standards in seafood contamination research (Rotkin-Ellman et al., 2012; Rotkin-Ellman and Soloman, 2012). Whether or not disproportionate long-term health impacts to low-income and minority populations will occur is unknown, although scientific research continues.

The Gulf Coast Claims Facility was replaced by a Court Supervised Settlement Program that has been in operation since June 4, 2012 (Gulf Coast Claims Facility, 2012). An Economic and Property Damages Settlement was reached in early 2012 and includes the following types of claims: seafood compensation; business economic loss; individual economic loss; loss of subsistence; vessel physical damage; Vessel-of-Opportunity charter payment; coastal real property damage; wetlands real property damage; and real property sales loss. A Medical Benefits Settlement was also reached in early 2012 and offers benefits to qualifying people who resided in the United States as of April 16, 2012, who were either "Clean-Up Workers" or who were residents in certain defined beachfront areas and wetlands ("Zones") during certain time periods in 2010. On May 2, 2012, the Court granted preliminary approval for the settlement and ordered that the Court-supervised settlement program begin accepting claims on June 4, 2012. For economic and property damages, valid claims will be paid as they are approved. For medical claims, payments and other benefits will be distributed after the final approval of the settlement and any appeals are resolved. The official Court-authorized claims administration website can be found on the *Deepwater Horizon* Claims Center website (*Deepwater Horizon* Claims Center, 2013a). Persons who filed a claim with the Gulf Coast Claims Facility for losses, such as subsistence, whose claims were rejected or who have not already accepted a final settlement from British Petroleum, may file a new claim with the *Deepwater Horizon* Claims Center (*Deepwater Horizon* Claims Center, 2013b).

While economic impacts were partially mitigated by employers retaining employees for delayed maintenance or through the Gulf Coast Claims Facility Program's emergency funds, the physical and mental health effects to both children and adults within these populations could potentially unfold for many years. As studies of past oil spills have highlighted, different cultural groups can possess varying capacities to cope with these types of events (Palinkas et al., 1992). Likewise, some low-income and/or minority groups may be more reliant on natural resources and/or less equipped to substitute contaminated or inaccessible natural resources with private market offerings. Because lower-income and/or minority populations may live near and may be directly involved with spill cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects. The post-*Deepwater Horizon*'s human environment remains dynamic, and BOEM will continue to monitor these populations over time and to document short- and long-term impacts. BOEM has funded a study on the social impacts of the oil spill. This study is currently ongoing and explores impacts through a two-pronged approach that involves ethnographic fieldwork combined with demographic analysis. The long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response will become clearer as time allows the production of peer-reviewed research and targeted studies that determine those impacts.

The types of accidental events (smaller, shorter time scale) that are likely to result from a CPA proposed action may affect low-income and/or minority populations more than the general population, at least in the shorter term. These higher risk groups may lack the financial or social resources and may be more sensitive and less equipped to cope with the disruption these events pose. These smaller events, however, are not likely to significantly affect minority and low-income populations in the long term.

Summary and Conclusion

BOEM has reexamined the analysis for environmental justice presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. BOEM has determined that the additional information does not alter the impact conclusion for environmental justice because the information is currently inconclusive with regard to environmental justice issues and will remain so for an indefinite period of time. Therefore, the analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

Cumulative Impacts

Background/Introduction

The cumulative analysis considers impacts that may result from a CPA proposed action within the context of OCS oil- and gas-related and non-OCS oil- and gas-related, impact-producing factors for environmental justice. The OCS oil- and gas-related, impact-producing factors include OCS leasing, exploration, development, and production activities, and accidental events arising from these OCS activities. Non-OCS oil- and gas-related, impact-producing factors include human activities and natural events. The context in which people may find themselves and how that context affects their ability to respond to an additional change in the socioeconomic or physical environment is the heart of an environmental justice analysis. The OCS Program in the GOM is large and has been ongoing for more than 50 years, with established infrastructure, resources, and labor pools to accommodate it. That said, low-income and/or minority groups lacking financial, social, or environmental resources or practical alternatives may be more sensitive than other groups to the consequences of an oil spill, such as interruptions to municipal services or fisheries closures, and they may be less equipped to cope with these consequences. In studies on social disaster resiliency, variables such as income inequality can negatively impact a community's ability to respond, and recover, from a disaster (Norris et al., 2008). Groups may be even less equipped to respond to these types of events if they are already in the process of recovering from a disaster, such as a hurricane. On the other hand, Cutter et al. (2008) found that previous disaster experience, defined as the number of paid disaster declarations, positively affected disaster resilience. This cumulative impact analysis examines how incremental additions to an established program from a CPA proposed action may potentially interact within these ongoing external impacts along the Gulf Coast. The oil and gas industry and its associated support sectors are interlinked and widely distributed along the Gulf Coast. Offshore OCS oil- and gas-related industry operations within the CPA may utilize onshore facilities located within the WPA, CPA, or both planning areas. In accordance with NEPA and the Executive Orders, BOEM must provide opportunities for community input during the NEPA process. Minority and low-income populations are provided the same opportunities as other communities to engage in the decisionmaking process.

OCS Oil- and Gas-Related Impacts

A CPA proposed action and the OCS Program have the potential to adversely impact low-income, minority, and other environmental justice communities either directly or indirectly from onshore activities conducted in support of OCS exploration, development, and production and in onshore response activities associated with accidental events such as the *Deepwater Horizon* explosion, oil spill and response. Potential vectors for impacts include increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic), additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste), and additional accidental events such as oil or chemical spills. BOEM estimates that production from a CPA proposed action will be 0.460-0.894 BBO and 1.939-3.903 Tcf of gas (**Table 3-1**). The cumulative oil and gas production in the CPA for the OCS Program (2012-2051) is estimated at 15.825-21.733 BBO and 63.347-92.691 Tcf of gas. Chapters 4.2.1.23.1.1 and 4.2.1.23.3.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapters 4.2.1.23.1 and 4.2.1.23.3 of the WPA 233/CPA 231 Supplemental EIS describe 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 oil- and gas-related infrastructure serves to limit the magnitude of effects that a single CPA proposed action or the overall OCS Program may have on any particular community. Future lease sales will serve mostly to maintain the ongoing activity levels associated with the current OCS Program.

For most of the Gulf Coast, the OCS Program will result in only minor economic changes. Generally, effects will be widely yet thinly distributed across the Gulf Coast and will consist of slight increases in employment and few, if any, increases in population. Some places could experience elevated employment, population, infrastructure, and/or traffic effects because of local concentrations of fabrication and supply operations. Because of Louisiana's extensive oil-related support system, it is likely to experience more employment effects related to a CPA proposed action than are the other coastal states. Because Lafourche Parish, Louisiana, already services about 90 percent of all deepwater oil production and 45 percent of all shallow-water oil and gas production in the Gulf, it is likely to continue experiencing benefits from the OCS Program (Loren C. Scott & Associates, 2008). Except in Louisiana, the OCS Program is expected to provide little additional employment, although it will serve to maintain current activity levels, which is expected to be beneficial to Gulf region low-income and minority populations generally. Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One Agency-funded study found income inequality in Louisiana decreased during the oil boom and increased with the decline (Tolbert, 1995).

A CPA proposed action will generate significant new infrastructure demand. Pipeline shore facilities are small structures, such as oil metering stations, associated with pipeline landfalls. In the Gulf of Mexico region, there are 129 OCS oil- and gas-related pipeline landfalls and 53 OCS oil- and gas-related pipeline shore facilities in the GOM region (**Table 4-24**). **Chapter 3.1.2** discusses projected new coastal infrastructure that may result from a CPA proposed action, including the potential need for the construction of new facilities and/or the expansion of existing facilities. Each OCS oil- and gas-related facility that may be constructed onshore must receive approval by the relevant Federal, State, and local agencies. Each onshore pipeline must obtain similar permit approval and concurrence. BOEM assumes that all such approval would be consistent with appropriate land-use plans, zoning regulations, and other Federal/State/regional/local regulatory mechanisms. Should a conflict occur, BOEM assumes that approval would not be granted or that appropriate mitigating measures would be enforced by the responsible political entities, such as USEPA, the Louisiana Department of Natural Resources, the Louisiana Department of Environmental Quality, or the Alabama Department of Environmental Management.

The Gulf Coast region as a whole is not homogenous, but there are several potentially vulnerable ethnic and socioeconomic groups, some residing in enclaves, dispersed throughout Gulf of Mexico OCS economic impact areas. Ten counties/parishes possess high concentrations of oil-related infrastructure, but they do not generally include high concentrations of minority and low-income populations. In the 10 high infrastructure concentration counties/parishes, many of the low-income and minority populations reside in large urban areas where the complexity and dynamism of the economy and labor force preclude measurable lease sale-level or programmatic-level OCS effects (Kaplan et al., 2011). A list of the counties and parishes in the Gulf of Mexico region with high, medium, and low concentrations of OCS oil- and gas-related infrastructure can be found in **Table 4-25**.

Two local infrastructure issues analyzed in Chapter 4.2.1.23.4.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.23.4 of the WPA 233/CPA 231 Supplemental EIS could possibly have related environmental justice concerns: traffic on LA Hwy 1 and the ongoing Port Fourchon expansion. This analysis concludes that the minority and low-income populations of Lafourche Parish will share the negative impacts of the OCS Program with the rest of the population. However, most effects are expected to be economic and positive, as in the areas of job creation and economic stimulation. Improvements to the Port Fourchon highway system are ongoing and upon completion will alleviate many of the associated transportation issues.

Impacts, including how communities respond to fluctuations in industry activity, vary from one coastal community to the next. 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. Overall, OCS programmatic impacts to environmental justice over the next 40 years will likely represent a very small proportion of the cumulative impacts of all activities that affect environmental justice.

Based on operator data provided in filed plans, BOEM estimates that there is an average of 2,000 ft^3 (57 m^3) of trash and debris generated per exploration well drilled, 102 ft^3 (3 m^3) of trash and debris generated per development well drilled, and 1,000 ft^3 (28 m^3) of trash and debris generated per year per manned platform of its 25-year life (Dismukes et al., 2007). A single CPA proposed action usually represents <1 percent of the total current permitted landfill capacity in a GOM economic impact area. Because of technological improvements on how waste is compacted, landfill capacity has increased, with Texas landfills having increased useful life by 19 years from the mid-1990's to 2005. Drilling muds and wastewater streams can be used as landfill cover, and landfills will often accept these materials at a reduced price or even at no charge (The Louis Berger Group, Inc., 2004). The occurrence of hazardous offshore, oil-field waste is minimal and infrequent. Industry representatives contracted for a BOEM study indicated that the need for hazardous storage could occur as infrequently as once in 5 years for a typical offshore facility with drilling and production activities (Dismukes et al., 2007). **Table 4-26** lists where existing waste sites are located and the amount of waste that was generated by the *Deepwater Horizon* explosion, oil spill, and response and that was distributed between Gulf landfills and waste processing facilities. Argonne National Laboratory reported that there are 46 waste management facilities that service the oil and gas industry along the GOM, with 18 in Louisiana, 18 in Texas, 5 in Mississippi, 4 in Alabama, and 1 in Florida (Puder and Veil, 2006). Because of existing capacity, no new waste disposal sites are projected for the cumulative case (The Louis Berger Group, Inc., 2004). Therefore, no changes in impacts to minority and low-income communities are expected.

While the long-term social impacts of the *Deepwater Horizon* explosion, oil spill, and response have yet to be determined, anecdotal evidence from media coverage and early survey studies suggested the possibility of trends that might disproportionately affect low-income and minority communities for some time to come. A phone survey conducted by a team of Louisiana State University sociologists found that nearly 60 percent of the 925 coastal Louisiana residents interviewed reported being almost constantly worried by the *Deepwater Horizon* explosion, oil spill, and response (Lee and Blanchard, 2010). Studies of residents near past oil spills (such as the *Exxon Valdez* in Prince William Sound, Alaska) have noted impacts to social cohesion and increased distrust in government and other institutions, which contributed to community anxiety (Tuler et al., 2009). Refer to **Appendix B** for a detailed discussion of a low-probability, high-impact catastrophic oil spill.

Cumulative effects from oil-spill events on social organization could include fragmentation of the family, cooperation, sharing, and subsistence availability. Long-term effects on wild resource harvest patterns might also be expected. While acute health effects from oil-spill events have been somewhat studied, the long-term impacts from exposure are unknown (Aguilera et al., 2010; Meo, 2009; Morita et al., 1999; Sathiakumar, 2010). The National Institutes of Health's long-term health surveillance studies of possible long-term health effects from exposure to either the *Deepwater Horizon* explosion, oil spill, and response's oil or dispersants, such as the possible bioaccumulation of toxins in tissues and organs, are ongoing. The potential for the long-term human health effects remains largely unknown. Participants in the *Deepwater Horizon* "Vessels of Opportunity" program, which recruited local boat owners (including Cajun, Houma Indian, and Vietnamese fishermen) to assist in cleanup efforts, may be one of the exposed groups. African Americans are thought to have made up a high percentage of the cleanup workforce. In Gulf coastal areas, low-income and minority groups are heavy subsistence users of local seafood. Worker and shoreline monitoring data indicate that the concentrations of oil and dispersants to which low-income and minority communities may have been exposed are unlikely to result in adverse health effects (King and Gibbons, 2011; Middlebrook et al., 2011; U.S. Dept. of Labor, OSHA, 2010a and 2010b). One concern is that heavy subsistence users may face higher than expected, and potentially harmful, exposure rates to PAH's from the *Deepwater Horizon* explosion, oil spill, and response. However, fisheries closures may have temporarily limited access to subsistence foods, thereby also reducing the potential of oil dispersant exposure, especially since fisheries were not reopened until testing indicated that the waters were safe for fishing. Extensive seafood testing for PAH's and dispersant compounds found levels that were within the risk assessment protocol established by the U.S. Food and Drug Administration, NOAA, and the Gulf Coast States (Brown et al., 2011; Dickey, 2012). It should be noted that there is some dispute within the scientific community over the validity of the risk assessment protocol that was used, and there is concern that the levels of concern established by the protocol may have underestimated the risk from seafood contaminants among vulnerable populations such as pregnant women and children (Rotkin-Ellman et al., 2012; Rotkin-Ellman and Soloman, 2012). The U.S. Food and Drug Administration defended the protocol as valid (Dickey, 2012). Future long-term studies may help to resolve the dispute. For purposes of this Supplemental EIS, BOEM has conservatively assumed that fish consumption remains a potential pathway for impacting the local population in the event of a low-probability catastrophic event.

The National Institutes of Health's proposed study, known as the Gulf Long-Term Follow-Up Study (GuLF STUDY), is expected to provide a better understanding of the long-term and cumulative health impacts, such as the consequences of working close to a spill and of consuming contaminated seafood. The GuLF STUDY will monitor oil-spill cleanup workers for 10 years. The GuLF STUDY has closed enrollment with nearly 33,000 participants. Of the study participants, 82 percent live in the five Gulf Coast States and 18 percent are from other states. Minority and low-income persons comprise 38 percent and 26 percent, respectively, of study participants. All of the participants either helped with the cleanup effort (74%) or were trained but did not actually help with the cleanup (26%) (National Institute of Environmental Health Sciences, 2013).

Studies that seek to understand the short- and long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response are ongoing regarding environmental justice concerns. BOEM modified an ethnicity study immediately after the oil spill started and added an oil-spill impact component, which allowed them to task ethnographers who were already on the ground in Louisiana and Mississippi. In mid-2010, BOEM also funded a study to document subsistence in the region. In 2012, BOEM kicked-off a study on the social impacts of the oil spill and explores impacts through a two-pronged approach that involves ethnographic fieldwork combined with demographic analysis. The NRDA process may also help us to understand issues relating to subsistence and other indigenous reliance on natural resources.

The National Institute of Environmental Health Sciences awarded a 5-year $7.85 million grant to a consortium of university researchers and regional community groups; the consortium will be led by the University of Texas Medical Branch at Galveston. The study, known as *Gulf Coast Health Alliance: Health Risks Related to the Macondo Spill* (GC-HARMS), will be focused on gaining an understanding of the long-term health effects attributable to the *Deepwater Horizon* oil spill. The GC-HARMS will examine and analyze human exposure and seafood contamination by "measuring the distribution of potentially carcinogenic petrogenic polycyclic aromatic hydrocarbons (PAH) present in weathered oil" (University of Texas Medical Branch, 2013). University researchers will work closely with community partners using a Community-Based Participatory Research approach. The community groups will connect researchers with local fishermen who will be trained to do sampling from not only their commercial catches but also from their bycatch, which they consume and frequently share or barter through extended families. They will also serve as partners in the effort to determine how seafood is distributed in local subsistence communities. The GC-HARMS will also include an outreach effort to inform Gulf Coast residents of the study's findings and other relevant research (University of Texas Medical Branch, 2013).

The *Deepwater Horizon* explosion, oil spill, and response stimulated increased community outreach projects. For example, the Mississippi Coalition for Vietnamese-American Fisher Folks and Families (MCVAFF) continued its extensive post-oil spill outreach efforts by helping to facilitate a NRDA/Early Coastal Restoration training in 2012 that over 80 Vietnamese-American fisher folks attended. The MCVAFF provided qualified interpreters and translated materials to ease communication throughout the training. A series of early Coastal Restoration public meetings in the coastal counties of Mississippi were also widely attended by fisher folks who were able to participate in the process and present ideas for coastal restoration projects (USEPA, 2013d).

Minority and low-income populations who may have a claim against the responsible party have faced a difficult claim-resolution process that evolved in the post-spill environment. The Gulf Coast Claims Facility was replaced by a Court Supervised Settlement Program that started operations on June 4, 2012 (Gulf Coast Claims Facility, 2012). An Economic and Property Damages Settlement was reached in early 2012 and includes the following types of claims: seafood compensation; business economic loss; individual economic loss; loss of subsistence; vessel physical damage; Vessel-of-Opportunity charter payment; coastal real property damage; wetlands real property damage; and real property sales loss. A Medical Benefits Settlement was also reached in early 2012 and offers benefits to qualifying people who resided in the United States as of April 16, 2012, who were either "Clean-Up Workers" or who were residents in certain defined beachfront areas and wetlands ("Zones") during certain time periods in 2010. The official Court-authorized claims administration website can be found on the *Deepwater Horizon* Claims Center website (*Deepwater Horizon* Claims Center, 2013a). Persons who filed a claim with the Gulf Coast Claims Facility for losses, such as subsistence, whose claims were rejected, or who have not already accepted a final settlement from British Petroleum may file a new claim with the *Deepwater Horizon* Claims Center (*Deepwater Horizon* Claims Center, 2013b).

Whether or not long-term impacts to low-income and minority populations will occur is unknown. As studies of past oil spills have highlighted, different cultural groups can possess varying capacities to cope with these types of events (Palinkas et al., 1992). Likewise, some low-income and/or minority groups may be more reliant on natural resources and/or less equipped to substitute contaminated or inaccessible natural resources with private market offerings. Because lower-income and/or minority populations may live near and may be directly involved with spill cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects. BOEM will continue to monitor these populations over time and to document short- and long-term impacts. Information regarding the long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response remains incomplete, and scientific research is ongoing. Information from the NRDA process is unavailable and unobtainable at this time. In its place, BOEM's subject-matter experts have used credible information that is available and applied it using accepted socioeconomic methodologies. BOEM will continue to seek additional information as it becomes available and bases the previous analysis on the best information currently available.

In addition to oil-spill events, public health also may be affected by routine OCS oil- and gas-related activities, though it is difficult to determine whether the impact is directly or indirectly related to oil and gas activities on the OCS since there are also extensive oil and gas activities onshore. Public health is a unique factor for this cumulative analysis because it is applicable to either or both OCS oil- and gas-related and non-OCS oil- and gas-related analyses. The complexity of making that determination, teasing out which does what and where, is far beyond the scope of this analysis.

The Natural Resources Defense Council and the National Disease Clusters Alliance identify and track disease clusters in the U.S. An unusually large number of people sickened by a disease in a certain place and time is known as a "disease cluster" (Natural Resources Defense Council and National Disease Clusters Alliance, 2011). The underlying causes of a disease cluster can be genetic, environmental, or both. The State of Louisiana's Center for Environmental Health defines an environmental disease cluster when evidence of a known connection between the hazard and the disease or health outcome of concern is established (State of Louisiana, Dept. of Health and Hospitals, 2008). The Natural Resources Defense Council and the National Disease Clusters Alliance identified disease clusters in 13 states, with four clusters in Louisiana and three clusters in Florida. The four locations in Louisiana include Mossville in Calcasieu Parish, Amelia in St. Mary Parish, Coteau in Iberville Parish, and New Orleans in Orleans Parish. The exact cause of these clusters is unknown, but experts suspect environmental contaminants. The Agency for Toxic Substances and Disease Registry identified a cluster of breast cancer in an urban census tract at the Agricultural Street Landfill Superfund Site in New Orleans in a 2003 study. According to the Agency for Toxic Substances and Disease Registry, the site and neighborhood are contaminated with metals, PAH's, VOC's, and pesticides due to a contaminated landfill that operated from 1909 to 1962 and then was covered with dirt and used as a site for residential development in 1976. The area was designated a hazardous waste site in 1993. From 1986 through 1987, researchers from Louisiana State University Medical School identified a cluster of neuroblastoma, a type of brain cancer adjacent to a marine shale processor plant in Amelia, located in St. Mary Parish, Louisiana. There was insufficient data to link a hazardous waste incinerator at the marine shale processor plant, but in 2007 the owners paid the State government a settlement to close and remediate the site. In Florida, Palm Beach, Collier, and Manatee Counties each have confirmed disease clusters. Loxahatchee, Florida, located in Palm Beach County, has a pediatric brain cancer cluster thought to be caused by spills of chemicals, solvents, and pesticides from a rocket and jet engine company. Immokalee, Florida, located in Collier County, is site of a birth defect disease cluster believed to be caused by an agricultural corporation that used six of the most dangerous pesticides in excessive levels. Tallevast, Florida, located in Manatee County, is home to a cancer disease cluster caused by prior long-term use of contaminated groundwater that resulted from improper disposal of a cancer-causing solvents such as trichloroethylene at a machine parts manufacturing plant (Natural Resources Defense Council and the National Disease Clusters Alliance, 2011). Disease clusters are included here because even though a direct cause-effect relationship has not been established between OCS activities and the occurrence of these clusters, it cannot be stated emphatically that OCS activities have or have not been a contributing factor to some of these problems. Clearly, impacts to public health can occur because of non-OCS and OCS oil- and gas-related activities whether from marine shale processors or waste brought to landfills or from environmental contamination from non-OCS oil- and gas-related industrial concerns or upstream and downstream facilities attached to either or both onshore and offshore oil and gas activities. The most important question, and one that has proved impossible to answer, is how much of actual OCS oil- and gas-related activities, i.e., offshore activity in Federal waters, may contribute to these problems. This cannot be definitively determined. There are numerous non-OCS oil- and gas-related activities that also contribute to these public health problems, such as State oil and gas activities, both onshore and offshore in State waters, as well as other industrial activities onshore that have produced various landfill-destined waste products and/or discharged toxic liquid waste and air emissions.

Due to the distance of OCS oil- and gas- related activities offshore, routine events related to a CPA proposed action would not be expected to directly affect public health in these communities, though it is not unlikely that members of these communities could participate in cleanup efforts if there was an oil-spill event. An environmental justice analysis seeks to identify populations that, through a variety of mechanisms, may become disproportionately impacted by a CPA proposed action and associated activities. Research like this suggests that there may be a correlation between downstream oil and gas processing (after any OCS Program-related oil and gas comes ashore) and diminished health in adjacent populations. As a result, communities appearing to have disease clusters are probably more sensitive to potential impacts in a cumulative scenario.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS oil- and gas-related impacts cover a wide range of potential impact-producing factors, including all human activities and natural events and processes that are not related to OCS oil- and gas-related activities. Some of the human activities that may disproportionately affect low-income and minority populations include, but are not limited to, the following: urbanization; pollution (air, light, noise, garbage dumping, and contaminated runoff); commercial/residential/agricultural development; zoning ordinances; community development strategies (multi-purpose, single-use); expansions to the Federal, State and local highway systems; expansions to regional port facilities; military activities; demographic shifts (in-migration, out-migration); economic shifts on the national, State and local levels (job creation and job losses); military activities; educational systems (quality, availability, expansions or contractions); family support systems (availability, proximity and quality of mental health services, foster care, charity hospital systems, addictive disorders rehabilitation centers, planned parenthood, head start programs, etc.); governmental functions (municipal waterworks systems, sewage systems, tax structures, revenue collection, law enforcement, fire protection, traffic control, voting processes, legislative processes, court procedures and processes, real estate property assessments, construction permits, environmental protection services, land-use permits, etc.); contraction or expansion of the tourism industry; financial system (banking and investment services); State renewable energy activities; river channelization, dredging of waterways; State oil and gas activity; existing infrastructure associated with downstream activities such as petrochemical processing; and public health.

Urbanization may disproportionately impact low-income and minority populations who make up the larger portion of an urban population and thus may be subjected to high levels of pollution (air, light, noise, litter/dumping) that often exist in urban areas. Commercial and residential developments may produce a disproportionate affect if the low-income and minority population's interests are not adequately represented at public hearings. Agricultural development has often contributed (and may continue to contribute) to the loss of wetlands and deforestation, which is a problem for subsistence populations who are often low-income and minority and depend on the wetlands and forests for their subsistence activities. When Federal, State, and local highway systems and regional port facilities are expanded, there is a tradeoff between the benefits of expansion and the potential negative impact to the local environment. Low-income and minority populations share in those positive and negative impacts. Likewise, when the Federal, State, and/or local economic conditions deteriorate (job losses), low-income and minority populations with less financial resources may bear the brunt of the impact. Military activities such as military base closures resulting in job losses and the resulting direct, indirect, and induced economic impacts for surrounding communities, as well as infrastructure expansion at military bases, may produce both negative and positive effects on nearby low-income and minority populations. Demographic shifts, such as out-migration, which often occur with major economic downturns, affect whole communities. However, economic upturns and demographic in-migration may benefit low-income and minority populations. Similarly, the status of a community's educational system may be a positive or negative benefit to these populations, depending on the quality of the educational facilities and infrastructure, the teacher to student ratios, the standardized test scores, the amount and extent of busing across cities and towns, and the availability of special education services in the public schools. All of these factors contribute to the quality of the educational system in these communities. Another very important non-OCS oil- and gas-related, impact-producing factor for low-income and minority populations involves family support services systems, namely their availability, proximity, and quality. Social services such as mental health support, charity hospitals, addictive disorder rehabilitation, foster care, head start programs, and planned parenthood are often hard to find in rural areas, but these services may be more accessible in larger cities, towns, and urban areas.

Other human activities that also may have disproportionate positive or negative impacts on low-income and minority populations are related to local, State, and Federal government functions, which are numerous and expansive. Two of the more crucial government functions for basic community functioning involve municipal waterworks and sewage systems. If these are not maintained in good condition with adequate capacity, low-income and minority populations may suffer disproportionate negative impacts. Another important factor to consider is the contraction and expansion of the tourism industry, which is very important to the economies of the Gulf of Mexico region. When there is a contraction in the tourism sector, the negative effects are felt by all those connected, but the effects may be disproportionately felt by low-income and minority populations in any area that they may constitute a larger presence. These same populations may experience disproportionate negative effects related to the financial system, namely access to loans, investment planning, and insurance. State renewable energy programs are non-OCS oil- and gas-related and may also provide a vector for disproportionate impacts due to their potential placement on or near fishing and hunting grounds that are crucial for subsistence users. River channelization and dredging of other waterways are also potential negative impacts for low-income and minority populations where they may have traditionally fished and tended oyster beds.

Additionally, onshore human activities conducted in support of State oil and gas exploration, development, and production have the potential to adversely impact low-income, minority, and other environmental justice communities either directly or indirectly. Louisiana, Mississippi, and Alabama's jurisdiction over mineral resources extends 3 nmi (3.5 mi; 5.6 km) from the shore; Texas and the west coast of Florida's jurisdiction over the seabed extends out 9 nmi (10.4 mi; 16.7 km). The annual gas production from Alabama State waters has ranged from 150 to 200 billion cubic feet or approximately 50 percent of the State's total gas production (State of Alabama, n.d.). While offshore leasing in shallow waters is in general decline, states like Louisiana are attempting to incentivize increased activity closer to the shore. In 2006, the Louisiana Legislature authorized the Louisiana Department of Environmental Quality to implement an Expedited Permit Processing Program, which has so far resulted in a 55-percent reduction in coastal permitting time (State of Louisiana, Dept. of Natural Resources, 2009). In November 2010, Louisiana voters passed the Louisiana Natural Resource Severance Tax Amendment, which effectively decreases the amount of taxes retained by the State on the severance of natural resources, but it increases what can be collected by the parishes where resources are extracted (State of Louisiana, 2010). Whether this measure will increase individual parishes' incentive to encourage production closer to the coast is still unknown.

State offshore oil and gas programs pose the same potential issues as does the OCS Program, although since State leases are closer to land, their petroleum-related activities are generally viewed as having greater potential for directly impacting coastal communities. BOEM assumes that sitings of any future facilities associated with State programs will be based on the same economic, logistical, zoning, and permitting considerations that determined past sitings. Revenues from oil programs in State waters have produced several positive impacts, and the steady stream of oil exploration and development have produced positive cumulative impacts that include increased funding for infrastructure, higher incomes (that can be used to purchase better equipment for subsistence), better health care, and improved educational facilities. While industrialization generally leads to a shift in community organization and cultural development, the offshore oil and gas industry and its concentrated work schedule has been more accommodating of "traditional" activities, such as trapping and fishing, during their time at home (Luton and Cluck, 2004).

Existing onshore infrastructure associated with petrochemical processing, including refineries (such as polyvinyl plants) and the production of petroleum-based goods, poses potential health and other related risks to minority and low-income communities. Expectations for new gas processing facilities being built during the period 2012-2051 as a direct result of the OCS Program are dependent on long-term market trends that are not easily predictable over the next 40 years. Existing facilities will experience equipment switch-outs or upgrades during this time. The marginal contribution of a CPA proposed action does not change the estimate. The geographic distribution of projected gas processing facilities differs markedly from the current distribution. BOEM cannot predict and does not regulate the siting of future gas processing plants. BOEM 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. An environmental justice study of industrial siting patterns in Jefferson, St. Bernard, and Lafourche Parishes in Louisiana (Hemmerling and Colten, 2003) found that "people appear to be moving into densely populated, largely industrial areas where the costs of rent are lower. In addition, people tend to be moving into newer housing." This historical analysis revealed little evidence of systematic environmental injustice of various oil-related industries, with the demographic makeup of the communities changing after facilities arrived.

While human activities are extensive and nearly all-encompassing, there are a substantial number of natural events and processes that may be classified as non-OCS oil- and gas-related impacts and that are unassociated with OCS-based oil and gas activities. Some of the natural events and processes that low-income and minority populations may be disproportionately affected by include, but are not limited to, the following: oyster reef degradation; saltwater intrusion; sedimentation of rivers; sediment deprivation; barrier island migration and erosion; fish kills; red tide; beach strandings; coastal erosion/subsidence; sea-level rise; and coastal storms.

Low-income and minority populations in the coastal region are often subsistence users, and many depend on the harvesting of oysters for either subsistence or financial income. There are a large number of African-American oyster harvesters in Plaquemines Parish, Louisiana, for example. The health of the oyster beds is critical to these populations. When degradation of oyster reefs occurs, it may negatively and disproportionately affect low-income and minority populations by decreasing the number of oysters that are able to harvest for economic and subsistence uses. Saltwater intrusion affects oyster reefs and the overall wetlands ecosystem, which is where these populations hunt and fish. In some places there is too much sediment deposited in waterways, and in others there is sediment deprivation; both of these serve to negatively impact the delicate ecosystem upon which these people depend. Barrier islands are very important to low-income and minority populations who make their living fishing these areas. The barrier islands in the regions have been migrating and eroding for decades. This natural process is one of the challenges faced in the region and contributes to cumulative effects. Low-income and minority populations may also be disproportionally affected by the negative impacts of fish kills, red tide, and beach strandings, which all may interfere with their use of the land for subsistence and economic purposes.

Coastal erosion and subsidence in some parts of the southeastern coastal plain serves to amplify the vulnerability of communities, infrastructure, and natural resources to storm-surge flooding (Dalton and Jones, 2010). Submergence in the Gulf area 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). Natural drainage patterns along many areas of the Gulf Coast areas have been severely altered by construction of the Gulf Intracoastal Waterway and other channelization projects associated with its development. Saltwater intrusion resulting from river channelization and canal dredging is a major cause of coastal habitat deterioration (Tiner, 1984; National Wetlands Inventory Group, 1985; Cox et al., 1997); refer to Chapter 4.2.1.4 of the 2012-2017 WPA/CPA Multisale EIS for a detailed discussion of wetlands in the CPA. As discussed in Chapter 4.2.1.23.4.1 of the 2012-2017 WPA/CPA Multisale EIS, tropical storms may be the norm in the region, but low-income and minority communities may bear a larger burden than the general populations when the amount of coastal erosion resulting from those storms is considered. Native Americans, Vietnamese, Cajuns, African Americans, and other ethnic enclaves have all borne catastrophic losses in recent storm events. An estimated 4,500 Native Americans living on the southeast Louisiana coast lost their possessions to Hurricane Katrina, according to State officials and tribal leaders. Cajuns were also impacted by Hurricane Katrina, and especially by Hurricane Rita, whose 20-ft (6-m) storm surges flooded low-lying communities in Cameron, Calcasieu, and other coastal parishes (Kaplan et al., 2011). According to a USGS 5-year, post-Katrina survey, the wetland loss in Louisiana from all four storms (Hurricanes Katrina, Rita, Gustav, and Ike) totaled 340 mi^2 (881 km^2). The U.S. Geological Survey projects that coastal Louisiana has undergone a net change in land area of about 1,883 mi^2 (4,877 km^2) from 1932 to 2010 (Couvillion et al., 2010).

A U.S. Geological Survey study published in early 2013, *Economic Vulnerability to Sea-Level Rise along the Northern U.S. Gulf Coast*, applied a CEVI to the northern Gulf coastal region in order to measure economic vulnerability to sea-level rise. The study attempted to determine which coastal communities may face the greatest challenges with regard to the economic and physical impacts of relative sea-level rise and revealed areas along the Gulf Coast that could most benefit from long-term resiliency planning. Within an area, the presence of a concentration of economically valuable infrastructure combined with physical vulnerability to inundation from sea-level rise resulted in the highest vulnerability rankings (CEVI score). The highest average CEVI score in the Gulf coastal region appeared in Lafourche Parish, Louisiana, where there is an extensive amount of valuable infrastructure related to the oil and gas industry, along with high relative sea-level rise rates and high coastal erosion rates. Terrebonne Parish, Louisiana, also received a high CEVI value because of its high level of physical vulnerability and high concentration of energy infrastructure. Due to limitations within the CEVI model, such as subjective weighting of variables, researchers caution that results of the study should remain within a vulnerability context and that CEVI results should only be considered relative measures that are best utilized to provide decisionmakers with a better understanding of the vulnerability of the coastal region's critical infrastructure when making decisions about modifying, protecting, or building new infrastructure in these coastal communities (Thatcher et al., 2013).

Coastal erosion, subsidence, and sea-level rise can increase community vulnerability to future hazards and also threaten traditional ways of life. Saltwater intrusion reduces the productivity and species diversity associated with wetlands and coastal marshes (Stutzenbaker and Weller, 1989; Cox et al., 1997). While users of coastal waters may trend towards the relatively affluent, low-income and minority groups may be more dependent on the resources of the Gulf Coast. Several ethnic minority and low-income groups rely substantially on these resources (e.g., refer to Hemmerling and Colten, 2003, for an evaluation of environmental justice considerations for south Lafourche Parish).

Hurricanes, tropical storms, and other wind-driven tidal or storm events are a fact of life for communities living along the Gulf of Mexico coastal zone. For low-income and minority populations, however, the impacts of coastal storm events can be particularly profound because of factors like limited resources to evacuate or to mitigate hazards. Baseline conditions pertaining to environmental justice were reevaluated in light of recent hurricane activity in the Gulf of Mexico. The intensity and frequency of hurricanes in the Gulf over the last several years has greatly impacted the system of protective barrier islands, beaches, and dunes and associated wetlands along the Gulf Coast. Within the last several years, the Gulf Coast of Texas, Louisiana, Mississippi, Alabama, and to some degree Florida have experienced five major hurricanes (Ivan, Katrina, Rita, Gustav, and Ike) as well as minor hurricanes (Humberto and Isaac). Impacts from future hurricanes and tropical storm events are uncertain. One study found that Galveston neighborhoods with higher proportions of renters, households in poverty, and minorities were more likely to have waited to evacuate the urbanized barrier island in advance of Hurricane Ike (Van Zandt et al., 2010). Municipal programs like the New Orleans Office of Homeland Security and Public Safety's City Assisted Evacuation Plan are being implemented to help citizens who want to evacuate during an emergency but lack the capability to self-evacuate (City of New Orleans, n.d.). Hazard mitigation funds available through individual states and the Federal Emergency Management Agency also seek to mitigate potential damage to homes in flood zones throughout the Gulf. While hurricanes and tropical storms are inevitable, lessons learned from Hurricanes Katrina, Rita, Gustav, and Ike are shaping local and national policies as well as nongovernmental organizations efforts to protect low-income, minority, and other vulnerable communities.

In addition to coastal storms, public health also may be considered a non-OCS oil- and gas-related factor. Public health is a unique factor for this cumulative analysis because it is applicable to both OCS oil- and gas-related and non-OCS oil- and gas-related analysis. Problems that the affect public health may be cause by either or both non-OCS oil- and gas-related and OCS oil- and gas-related activities. The complexity of making that determination, teasing out which does what and where, is far beyond the scope of this analysis. The Natural Resources Defense Council and the National Disease Clusters Alliance identify and track disease clusters in the U.S. An unusually large number of people sickened by a disease in a certain place and time is known as a "disease cluster" (Natural Resources Defense Council and National Disease Clusters Alliance, 2011). The underlying causes of a disease cluster can be genetic, environmental, or both. The State of Louisiana's Center for Environmental Health defines an environmental disease cluster when evidence of a known connection between the hazard and the disease or health outcome of concern is established (State of Louisiana, Dept. of Health and Hospitals, 2008). The Natural Resources Defense Council and the National Disease Clusters Alliance identified disease clusters in 13 states, with four clusters in Louisiana and three clusters in Florida. The four locations in

Louisiana include Mossville in Calcasieu Parish, Amelia in St. Mary Parish, Coteau in Iberville Parish, and New Orleans in Orleans Parish. The exact cause of these is unknown, but experts suspect environmental contaminants. The Agency for Toxic Substances and Disease Registry identified a cluster of breast cancer in an urban census tract at the Agricultural Street Landfill Superfund Site in New Orleans in a 2003 study. According to the Agency for Toxic Substances and Disease Registry, the site and neighborhood are contaminated with metals, PAH's, VOC's, and pesticides due to a contaminated landfill that operated from 1909 to 1962 and then was covered with dirt and used as a site for residential development in 1976. The area was designated a hazardous waste sight in 1993. From 1986 through 1987, researchers from Louisiana State University Medical School identified a cluster of neuroblastoma, a type of brain cancer adjacent to a marine shale processor plant in Amelia, located in St. Mary Parish, Louisiana. There was insufficient data to link a hazardous waste incinerator at the marine shale processor plant, but in 2007 the owners paid the State government a settlement to close and remediate the site. In Florida, Palm Beach, Collier, and Manatee Counties each have a confirmed disease cluster. Loxahatchee, Florida, located in Palm Beach County, has a pediatric brain cancer cluster thought to be caused by spills of chemicals, solvents, and pesticides from a rocket and jet engine company. Immokalee, Florida, located in Collier County, is site of a birth defect disease cluster believed to be caused by an agricultural corporation that used six of the most dangerous pesticides in excessive levels. Tallevast, Florida, located in Manatee County, is home to a cancer disease cluster caused by prior long-term use of contaminated groundwater that resulted from improper disposal of cancer-causing solvents such as trichloroethylene at a machine parts manufacturing plant. The complexity and inherent difficulty of investigating potential and suspected disease clusters often lead to inconclusive results. Scientific tools used to determine cause-and-effect in small populations are limited (Natural Resources Defense Council and the National Disease Clusters Alliance, 2011). This discussion shows that impacts to public health can occur because of non-OCS oil- and gas-related and OCS oil- and gas-related activities whether they are from marine shale processors or waste brought to landfills or from environmental contamination from non-OCS oil- and gas-related industrial concerns or upstream and downstream facilities attached to either or both onshore and offshore oil and gas activities.

Summary and Conclusion

The cumulative impacts of a CPA proposed action would occur within the context of other impact-producing factors for environmental justice. The OCS oil- and gas-related, impact-producing factors include OCS leasing, exploration, development, and production activities, and accidental events arising from these OCS activities. Non-OCS oil- and gas-related, impact-producing factors include human activities and natural events. Because of the presence of an extensive and widespread support system for the OCS and associated labor force, the OCS oil- and gas-related effects of the cumulative case are expected to be widely distributed and, except in Louisiana, little felt. In general, the cumulative OCS oil- and gas-related effects are expected to be economic and to 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. Given the existing distribution of the OCS oil- and gas-related industry and the limited concentrations of minority and low-income peoples, a CPA proposed action and the cumulative OCS Program are not expected to have disproportionate high/adverse environmental or health effects on minority or low-income populations. Lafourche Parish will experience the most concentrated effects of cumulative OCS oil- and gas-related impacts. However, these groups are not expected to be differentially affected because the parish is not heavily low-income or minority and because the effects of road traffic and port expansion would not occur in areas of low-income or minority concentration.

In the Gulf coastal area, the contribution of a CPA proposed action and the OCS Program to the cumulative effects of all non-OCS oil- and gas-related activities and trends affecting environmental justice issues over the next 40 years are 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 they are expected to make a positive contribution to environmental justice. The contribution of the cumulative OCS Program to the cumulative impacts of all factors affecting environmental justice is expected to be minor; therefore, the incremental contribution of a CPA proposed action to the cumulative impacts would also be minor. State offshore leasing programs in Alabama and Louisiana have similar, although more limited, effects due to their smaller scale. Cumulative effects from onshore infrastructure, including waste facilities, is also expected to be minor because existing infrastructure is regulated, because little new infrastructure is expected to result in the cumulative case, and because any new infrastructure will be subject to relevant permitting requirements. Other human activities and natural events and processes also may raise environmental justice issues. The cumulative consequences to environmental justice cannot be determined at this time. Nevertheless, when added to existing State and Federal leasing programs, the associated onshore infrastructure, and all of the non-OCS oil- and gas-related impacting factors, a single proposed CPA lease sale will make only minor contributions to the cumulative effects on environmental justice communities.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of various Internet information sources and trade publications (U.S. Department of Health and Human Services, National Institutes of Health; USEPA; USDOC, Bureau of the Census and Bureau of Labor Statistics; USDHS, Federal Emergency Management Agency; RestoreTheGulf.gov website; *Deepwater Horizon* Claims Center; *Deepwater Horizon* Oil Spill Portal; Louisiana Department of Environmental Quality; Mississippi Department of Environmental Quality; Alabama Department of Environmental Management; Florida Department of Environmental Protection; Louisiana Recovery Authority; and Louisiana Office of Community Development, The Greater Lafourche Port Commission, LA1 Coalition, Rigzone, *Oil and Gas Journal* and The Oil Drum), as well as recently published journal articles, was conducted to determine the availability of recent information on environmental justice. The search revealed the following new information.

The *Deepwater Horizon* explosion, oil spill, and response stimulated increased community outreach projects. For example, the Mississippi Coalition for Vietnamese-American Fisher Folks and Families continued its extensive outreach efforts by helping to facilitate a NRDA/Early Coastal Restoration training in 2012 that over 80 Vietnamese-American fisher folks attended. The Mississippi Coalition for Vietnamese-American Fisher Folks and Families provided qualified interpreters and translated materials to ease communication throughout the training. A series of Early Coastal Restoration public meetings in coastal counties of Mississippi were also widely attended by fisher folks who were able to participate in the process and present ideas for coastal restoration projects (USEPA, 2013d).

The National Institute of Environmental Health Sciences awarded a 5-year $7.85 million grant to a consortium of university researchers and regional community groups that will be led by the University of Texas Medical Branch at Galveston. The study, known as *Gulf Coast Health Alliance: Health Risks Related to the Macondo Spill* (GC-HARMS), will be focused upon gaining an understanding of the long-term health effects attributable to the *Deepwater Horizon* oil spill. The GC-HARMS will examine and analyze human exposure and seafood contamination by "measuring the distribution of potentially carcinogenic PAH's present in weathered oil" (University of Texas Medical Branch, 2013). University researchers will work closely with community partners using a Community-Based Participatory Research approach. The community groups will connect researchers with local fishermen who will be trained to do sampling from not only their commercial catches but also from their bycatch, which they consume and frequently share or barter through extended families. They will also serve as partners in the effort to determine how seafood is distributed in local subsistence communities. The GC-HARMS will also include an outreach effort to inform Gulf Coast residents of the study's findings and other relevant research (University of Texas Medical Branch, 2013).

A related effort, GuLF STUDY (a national effort to determine if the *Deepwater Horizon* oil spill led to physical or mental health problems), has enrolled nearly 33,000 participants. Of the study participants, 82 percent live in the five Gulf Coastal States and 18 percent are from other states. Minority and low-income persons comprise 38 percent and 26 percent, respectively, of study participants. All of the participants either helped with the cleanup effort (74%) or were trained but did not actually help with the cleanup (26%) (National Institute of Environmental Health Sciences, 2013).

A U.S. Geological Survey study, *Economic Vulnerability to Sea-Level Rise along the Northern U.S. Gulf Coast*, was published in spring 2013and applied a CEVI to the northern Gulf coastal region in order to measure economic vulnerability to sea-level rise. The study attempted to determine which coastal communities may face the greatest challenges with regard to the economic and physical impacts of relative sea-level rise, and it revealed areas along the Gulf Coast that could most benefit from long-term resiliency planning. Within an area, the presence of a concentration of economically valuable infrastructure, combined with physical vulnerability to inundation from sea-level rise, resulted in the highest vulnerability rankings (CEVI score). The highest average CEVI score in the Gulf coastal region appeared in Lafourche Parish, Louisiana, where there is an extensive amount of valuable infrastructure related to the oil and gas industry, along with high relative sea-level rise rates and high coastal erosion rates. Terrebonne Parish, Louisiana, also received a high CEVI value because of its high level of physical vulnerability and high concentration of energy infrastructure. Due to limitations within the CEVI model, such as subjective weighting of variables, researchers caution that results of the study should remain within a vulnerability context and that CEVI results should only be considered relative measures best utilized to provide decisionmakers with a better understanding of the vulnerability of the coastal region's critical infrastructure when making decisions about modifying, protecting, or building new infrastructure in these coastal communities (Thatcher et al., 2013).

Information regarding the impacts of the *Deepwater Horizon* explosion, oil spill, and response remains incomplete. Studies regarding environmental justice concerns in light of the *Deepwater Horizon* explosion, oil spill, and response are still ongoing, and it may be years before data are available. The NRDA process, which is ongoing, may help to inform issues relating to subsistence and other indigenous reliance on natural resources. However, information related to NRDA is unavailable and unobtainable at this time, regardless of costs. In its place, BOEM's subject-matter experts have used credible information that is available and applied it using accepted socioeconomic methodologies. Although most criteria related to environmental justice may not be essential to a reasoned choice among alternatives, health impacts may be essential. Nevertheless, long-term health studies are pending and may not be available for use for several years or longer. BOEM will continue to seek additional information as it becomes available and bases the previous analysis on the best information currently available.

Incomplete or unavailable information, identified in this Supplemental EIS, 2012-2017 WPA/CPA Multisale EIS, and WPA 233/CPA 231 Supplemental EIS, related to environmental justice may be relevant to reasonably foreseeable adverse impacts on minority and low-income communities. With regard to the *Deepwater Horizon* explosion, oil spill, and response, BOEM has determined that the incomplete or unavailable information would not be essential to a reasoned choice among alternatives for the reasons stated in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS.

4.1.1.24. Species Considered due to U.S. Fish and Wildlife Service Concerns

BOEM has reexamined the analysis for species considered due to FWS concerns presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented below. The species considered are the Louisiana black bear, gopher tortoise, Alabama red-belly turtle, ringed map turtle, black pine snake, yellow-blotched map turtle, eastern indigo snake, Mississippi gopher frog, frosted flatwoods salamander, reticulated flatwoods salamander, pallid sturgeon, pearl darter, inflated heelsplitter, Louisiana quillwort, and telephus spurge. The conclusions for the following species can be found in their respective chapters: West Indian manatee (**Chapter 4.1.1.12** of this Supplemental EIS and Chapter 4.2.1.12 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS); green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles (**Chapter 4.1.1.13** of this Supplemental EIS and Chapter 4.2.1.13 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS); and red knot (*Calidris canutus rufa*), piping plover, whooping crane, and mountain plover (**Chapter 4.1.1.16** of this Supplemental EIS and Chapter 4.2.1.16 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS). No new significant information was discovered that would alter the impact conclusion for species considered due to FWS concerns presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

BOEM has only focused on species within coastal counties because those are the species that could potentially be impacted by oil and gas development activities, including a potential OCS spill. Because of the mitigations that may be implemented (**Chapter 2.3.1.3**), routine activities (e.g., operational discharges, noise, and marine debris) related to a CPA proposed action are not expected to have long-term adverse effects on the size and productivity of any of these species or populations (one mammal species, six reptile species, three amphibian species, two fish species, one bivalve species, and two plant species) in the Gulf of Mexico. Lethal effects could occur from ingestion of accidentally released plastic materials from OCS vessels and facilities. However, there have been no reports to date on such incidences.

A detailed description of species considered due to FWS concerns can be found in Chapter 4.2.1.24 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 4.2.1.24 of the WPA 233/CPA 231 Supplemental EIS. A detailed explanation of the routine and accidental impact-producing factors can be found in **Chapters 3.1 and 3.2** of this Supplemental EIS and Chapters 3.1 and 3.2 of the 2012-2017 WPA/CPA Multisale EIS. The cumulative analysis in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS considers the effects of impact-producing factors related to past CPA lease sales, proposed CPA Lease Sales 235, 241, and 247, and reasonably foreseeable lease sale programs in the CPA. Cumulative impacts attributed to OCS activity co-occur with State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may occur that adversely affect wetlands.

Adverse impacts due to routine activities resulting from a CPA proposed action are possible but unlikely. Because of the greatly improved handling of waste and trash by industry and the annual awareness training required by the marine debris mitigations, it is likely that there are not as many plastics being added to the GOM and the devastating effects on offshore and coastal marine life are decreasing (USDOC, NOAA, 2011e). The routine activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any above-mentioned species or population in the GOM due to the distance from shore of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

Adverse impacts due to accidental events are also likely to be small. Accidental blowouts, oil spills, and spill-response activities resulting from a CPA proposed action have the potential to impact small to large areas in the Gulf of Mexico, 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 (including tropical storms). The incremental contribution of a CPA proposed action would not be likely to result in a significant incremental impact on these species within the CPA. A CPA proposed action would be expected to have little or no effect on these species of concern.

Cumulative activities posing the greatest potential harm to species considered due to FWS concerns are non-OCS oil- and gas-related factors such as habitat loss and competition. These factors have historically proved to be of greater threat to these species of concern.

At this time, there is no known record of a hurricane crossing the path of a large oil spill; the impacts of such have yet to be determined. The experience from Hurricanes Katrina and Rita in 2005 was that the oil released during the storms widely dispersed as far as the surge reached (USDOC, NOAA, 2010b). Due to their species' reliance on terrestrial habitats to carryout their life-history functions at a considerable distance from the GOM, the activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any of the above-mentioned species or populations in Texas, Louisiana, Mississippi, Alabama, and Florida.

As BOEM has previously noted in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, relevant data on the status of populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. As data continue to be gathered and impact assessments completed, a better characterization of the full scope of impacts to populations in the GOM from the *Deepwater Horizon* explosion, oil spill, and response will be available. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in the NEPA analysis of this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches. Nevertheless, a complete understanding of the unavailable information is not essential to a reasoned choice among alternatives for this Supplemental EIS. There are existing leases in the CPA with either ongoing or the potential for exploration, drilling, and production activities. In addition, non-OCS energy-related activities will continue to occur in the CPA irrespective of a CPA proposed action (i.e., habitat loss and competition). The potential for effects from changes to the affected environment (post-*Deepwater Horizon*), routine activities, accidental spills, low-probability catastrophic spills), and cumulative effects remains whether or not an Action or No Action alternative is chosen under this Supplemental EIS.

Summary and Conclusion

Because of the mitigations that may be implemented, routine activities (e.g., operational discharges, noise, and marine debris) related to a CPA proposed action are not expected to have long-term adverse effects on the size and productivity of any of these species or populations in the GOM. Lethal effects could occur from ingestion of accidentally released plastic materials from OCS oil- and gas-related and non-OCS oil- and gas-related vessels and facilities. However, there have been no reports to date on such incidences. BOEM employs several measures (e.g., marine debris mitigations) to reduce the potential impacts to any animal from routine activities associated with a CPA proposed action. Accidental blowouts, oil spills, and spill-response activities resulting from a CPA proposed action have the potential to impact small to large areas 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 (including tropical storms). The incremental contribution of a CPA proposed action would not be likely to result in a significant incremental impact on the above-mentioned species within the CPA; in comparison, non-OCS oil- and gas-related activities, such as habitat loss and competition, have historically proven to be a greater threat to the above-mentioned species.

BOEM has reexamined the analysis for species considered due to FWS concerns presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS, based on the additional information presented above. No new significant information was discovered that would alter the impact conclusion for species considered due to FWS concerns presented in the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS because of the available scientifically credible evidence in this analysis and based upon accepted scientific methods and approaches. The analysis and potential impacts detailed in the 2012-2017 WPA/CPA Multisale EIS and updated in the WPA 233/CPA 231 Supplemental EIS still apply for proposed CPA Lease Sales 235, 241, and 247.

There is a long-standing and well-developed OCS Program of more than 50 years within the CPA, and there are no data to suggest that activities from the preexisting OCS Program are significantly impacting the above-mentioned species populations; therefore, a CPA proposed action would be expected to have little or no effect on the above-mentioned species.

New Information Available Since Publication of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS

A search of Internet information sources (FWS's websites), as well as recently published journal articles was conducted to determine the availability of recent information on species considered due to FWS concerns. The search revealed no new information pertinent to this Supplemental EIS.

These one mammal species, six reptile species, three amphibian species, two fish species, one bivalve species, and two plant species within the CPA were not affected to any discernible degree by the *Deepwater Horizon* explosion, oil spill, and response, based on the best available information and the distance from the *Macondo* well. As identified in the resource analyses in this Supplemental EIS and 2012-2017 WPA/CPA Multisale EIS, and in the updated information provided in the WPA 233/CPA 231 Supplemental EIS, incomplete or unavailable information regarding these one mammal species, six reptile species, three amphibian species, two fish species, one bivalve species, and two plant species in the CPA are not relevant to reasonably foreseeable significant adverse effects. BOEM has determined that the information is not essential to a reasoned choice among alternatives.

4.1.2. Alternative B—The Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (the proposed action) by not offering blocks that are possibly affected by the proposed Topographic Features Stipulation (**Chapter 2.3.1.3.1** of this Supplemental EIS and Chapter 2.4.1.3.1 of the 2012-2017 WPA/CPA Multisale EIS). All of the assumptions (including the seven other potential mitigating measures) and estimates are the same as for the proposed action (Alternative A). A description of Alternative A is presented in **Chapter 2.3.1.1**.

Effects of the Alternative

The following analyses are based on the scenario for a CPA proposed action (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 would happen as a result of holding proposed CPA Lease Sales 235, 241, and 247. A detailed discussion of the scenario and related impact-producing factors is presented in **Chapter 3.1** of this Supplemental EIS and in Chapter 3.1 of the 2012-2017 WPA/CPA Multisale EIS, and updated information is provided in Chapter 3.1 of the WPA 233/CPA 231 Supplemental EIS.

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 a CPA proposed action (**Chapter 4.1.1**) for the following resources:

- Air Quality
- Water Quality
- Coastal Barrier Beaches and Associated Dunes
- Wetlands
- Seagrass Communities
- Live Bottoms (Pinnacle Trend and Low Relief)
- *Sargassum* Communities
- Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities
- Soft Bottom Benthic Communities
- Marine Mammals
- Sea Turtles
- Diamondback Terrapins
- Alabama, Choctawhatchee, St. Andrew and Perdido Key Beach Mice
- Coastal and Marine Birds
- Gulf Sturgeon
- Fish Resources and Essential Fish Habitat
- Commercial Fisheries
- Recreational Fishing
- Recreational Resources
- Archaeological Resources
- Human Resources and Land Use

The impacts to some Gulf of Mexico resources under Alternative B would be slightly different from the impacts expected under a CPA proposed action (Alternative A). These impacts are described below.

Impacts on Topographic Features

The sources and severity in impacts associated with this alternative are those lease sale-related activities discussed for a CPA proposed action. The potential impact-producing factors to the topographic features of the CPA are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors and the appropriate mitigating measures are presented in **Chapter 2.3.1.3.1** of this Supplemental EIS and Chapter 2.4.1.3.1 of the 2012-2017 WPA/CPA Multisale EIS.

Impacts of Routine and Accidental Events

Of the 16 topographic features in 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 would be eliminated by the adoption of this alternative. Effluent discharge and blowouts would 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 would 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 3.2.1** of this Supplemental EIS and in Chapter 3.2.1 of the 2012-2017 WPA/CPA Multisale EIS and the WPA 233/CPA 231 Supplemental EIS.

A subsurface spill would have no effect on a biologically sensitive feature unless the oil or its dissolved components comes into direct contact with the habitat. Oil from a subsurface spill is expected to rise to the sea surface, based on the specific gravity of Gulf of Mexico oil. An exception to this could occur if oil is released at the seafloor under high pressure, having the effect of atomizing the oil into micro-droplets that have very little buoyancy. Under these conditions, a subsea oil plume could form and travel laterally with the prevailing currents. This can also happen if chemical dispersants are used underwater, forming a plume. If a subsea oil plume does form, the oil is expected to be swept clear of the banks because prevailing currents travel around the banks rather than over them (Rezak et al., 1983). As the oil travels in the water column, it will become diluted from its original concentration. Transient concentrations of oil below 20 ppm are not expected to result in lasting harm to a coral reef (Shigenaka, 2001). The fact that the topographic features are widely dispersed in the CPA, combined with the random nature of spill events, would serve to limit the likelihood of a spill occurring near a topographic feature. In addition, the exclusion of blocks adjacent to topographic features from a proposed CPA lease sale would further distance potential spills from the habitat. Chapter 4.2.1.7 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS discusses the risk of spills interacting with topographic features in more detail. The currents that move around the banks would 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 (CSA, 1992 and 1994). If oil from a subsurface spill contacted a coral-covered area, 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). Stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature and diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Cumulative Impacts

With the exception of the topographic features, the cumulative impacts of Alternative B on the environmental and socioeconomic resources of the CPA would be identical to Alternative A. The incremental contribution of a CPA proposed action to the cumulative impacts on topographic features is expected to be slight, and negative impacts should be restricted by the implementation of the Topographic Features Stipulation and site-specific mitigations, the depths of the features, and water currents in the topographic feature area.

Summary and Conclusion

Alternative B, if adopted, would prevent any oil and gas activity whatsoever in the blocks containing topographic features and their surrounding protective zones ; thus, it would eliminate any potential direct impacts to the biota of those blocks from routine oil and gas activities within the blocks. 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.

Environmental impacts of Alternative B would be almost indistinguishable from Alternative A with the Topographic Features Stipulation in place. There would be an economic impact to the extent that economic returns from the excluded lease blocks would not be realized.

4.1.3. Alternative C—No Action

Description of the Alternative

Alternative C is the cancellation of a proposed CPA lease sale. If this alternative is chosen, the opportunity for development of the estimated 0.460-0.894 BBO and 1.939-3.903 Tcf of gas that could have resulted from a proposed CPA lease sale would be precluded during the current 2012-2017 Five-Year Program, but it could again be contemplated as part of a future Five-Year Program. The No Action alternative encompasses the same potential impacts as a decision to delay a proposed CPA lease sale to a later scheduled lease sale under the Five-Year Program, when another decision on whether to hold that future lease sale is made. Delay of a proposed CPA lease sale was not considered as a separate alternative from Alternative C because the potential impacts are the same, namely that most impacts related to Alternative A would not occur as described below. Any potential environmental impacts resulting from a proposed CPA lease sale would not occur or would be postponed to a future lease sale decision. This alternative is also analyzed in the EIS for the 2012-2017 Five-Year Program on a nationwide programmatic level.

Effects of the Alternative

This Agency published a report that examined previous exploration and development activity scenarios (USDOI, MMS, 2007). This Agency compared forecasted activity with the actual activity from 14 WPA and 14 CPA lease sales. The report shows that many lease sales contribute to the present level of OCS activity, and any single lease sale accounts for only a small percentage of the total OCS activities. In 2006, leases from 92 different sales contributed to Gulf of Mexico production, while an average CPA lease sales contributed to 2 percent of oil production and 2 percent of gas production in the CPA. In 2006, leases from 15 different sales contributed to the installation of production structures in the Gulf of Mexico, while an average CPA lease sale, for example, contributed to 6 percent of the installation of production structures in the CPA. In 2006, leases from 70 different sales contributed to wells drilled in the Gulf of Mexico, while an average CPA lease sale contributed to 4 percent of the wells drilled in the CPA.

As in the past, a proposed CPA lease sale would contribute to maintaining the present level of OCS activity in the Gulf of Mexico. Exploration and development activity, including service-vessel trips, helicopter trips, and construction that would result from a proposed CPA lease sale would replace activity resulting from existing leases that have reached, or are near the end of, their economic life.

Environmental Impacts

If a proposed CPA lease sale would be cancelled, the resulting development of oil and gas would most likely be postponed to a future sale; therefore, the overall level of OCS activity in the CPA would only be reduced by a small percentage, if any. Therefore, the cancellation of a proposed CPA lease sale would not significantly change the environmental impacts of overall OCS activity in the long term. The environmental impacts expected to result from a CPA proposed action, which are described above, would not occur in the short term, but they would likely be postponed to any future lease sale.

Economic Impacts

Although environmental impacts may be reduced or postponed by cancelling a proposed CPA lease sale, the economic impacts of cancelling the scheduled lease sale should be given consideration. Chapter 4.2.1.23.3.2 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.23.3 of the WPA 233/CPA 231 Supplemental EIS discusses the potential economic impacts of a CPA proposed action. In the event that a proposed CPA lease sale is cancelled or postponed, there may be impacts to employment along the Gulf Coast, but these are not expected to be significant (e.g., less than 1% of total employment) or long term given the existing OCS infrastructure.

Federal, State, and local governments would also have to forgo the revenue that would have been received from a proposed CPA lease sale. There could be minor impacts on global energy prices from cancelling the proposed CPA lease sale, along with minor changes in energy consumption patterns that would result from these price changes.

Other factors may minimize or exacerbate the economic impacts of cancelling a proposed CPA lease sale. For example, the longer-term economic impacts of cancelling the CPA proposed lease sale could be minimized if they were offset by a larger lease sale at a later date. The economic impacts may be exacerbated if additional lease sales are cancelled. The OCS industry is dependent on high capital investment costs and there may be long lags between the lease sale and the majority of production activities. Therefore, firms' investment and spending decisions are dependent on their confidence that the OCS Program will be maintained in the future. In addition, while firms in the OCS industry are generally likely to be able to weather the cancellation of a single lease sale, the cancellation of multiple lease sales could lead to broader damage to firms and workers in the industry or decisions to operate in areas other than the Gulf. These economic impacts would be particularly damaging to the coastal counties in Texas and Louisiana for which the OCS industry as a whole is an important component of their economies.

From a programmatic perspective, cancellation of a Five-Year Program of lease sales in the Gulf of Mexico would have much greater effects in terms of economic impacts, energy strategy, and environmental impacts. For a more detailed discussion of the effects of the cancellation of a Five-Year Program of lease sales in the Gulf of Mexico, refer to Appendix G of the 2012-2017 WPA/CPA Multisale EIS.

Summary and Conclusion

Cancelling a proposed CPA lease sale would eliminate the effects described for Alternative A (**Chapter 4.1.1**). 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. For example, tankering of fuels from alternate sources over longer distances would also have significant potential negative impacts, including through the increased risk of spills.

4.2. UNAVOIDABLE ADVERSE IMPACTS OF THE PROPOSED ACTIONS

Unavoidable adverse impacts associated with a CPA proposed action are expected to be primarily short term and localized in nature and are summarized below. Adverse impacts from low-probability catastrophic events could be of longer duration and extend beyond the local area. All OCS oil- and gas-related activities involve temporary and exclusive use of relatively small areas of the OCS over the lifetimes of specific projects. Lifetimes for these activities can be days, as in the case of seismic surveys; or decades, as in the case of a production structure or platform. No activities in the OCS Program involve the permanent or temporary use or “taking” of large areas of the OCS on a semicontinuous basis. Cumulatively, however, a multitude of individual projects results in a major use of OCS space.

Sensitive Coastal Habitats: If an oil spill contacts beaches or barrier islands, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced. In addition, a beach could experience several years of tarballs washing ashore over time, causing an aesthetic impact. Sand borrowing on the OCS for coastal restorations involves the taking of a quantity of sand from the OCS and depositing it onshore, essentially moving small products of the deltaic system to another location. If sand is left where it is, it would eventually be lost to the deltaic system by redeposition or burial by younger sediments; if transported onshore, it would be lost to burial and submergence caused by subsidence and sea-level rise.

If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In more heavily oiled areas, wetland vegetation could experience suppressed productivity for several years; in more lightly oiled areas, wetland vegetation could experience die-back for one season. Epibionts on wetland vegetation and grasses in the tidal zone could be killed, and the productivity of tidal marshes for the vertebrates and invertebrates that use them to spawn and develop could be impaired. Much of the wetland vegetation would recover over time, but some wetland areas could be converted to open water. Some unavoidable impacts could occur during pipeline and other related coastal construction, but regulations are in place to avoid and minimize these impacts to the maximum extent practicable. Unavoidable impacts resulting from dredging, wake erosion, and other secondary impacts related to channel use and maintenance would occur as a result of a CPA proposed action.

Sensitive Coastal and Offshore Biological Habitats: Unavoidable adverse impacts would take place if an oil spill occurred and contacted sensitive coastal and offshore biological habitats, such as *Sargassum* at the surface; fish, turtles, and marine mammals in the water column; or benthic habitats on the bottom. There could be some adverse impacts on organisms contacted by oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals that, at this time, are not completely understood, particularly in subsurface environments.

Water Quality: Routine offshore operations would cause some unavoidable adverse impacts to varying degrees on the quality of the surrounding water. Drilling, construction, overboard discharges of drilling mud and cuttings, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. This, however, would only affect water in the immediate vicinity of the construction activity or in the vicinity of offshore structures, rigs, and platforms. The discharge of treated sewage from manned rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and biochemical oxygen demand 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. Spilled oil from a tanker collision would affect the water surface in combination with dispersant chemicals used during spill response. A subsurface blowout would subject the surface, water column, and near-bottom environment to spilled oil and gas released from solution, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals.

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 water quality by chronic low-quantity 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 on air quality could occur after large oil spills and blowouts because of evaporation and volatilization of the lighter components of crude oil, combustion from surface burning, and aerial spraying of dispersant chemicals. Short-term effects from spill events are uncontrollable and are likely to be aggravated or mitigated by the time of year the spills take place. Mitigation of long-term effects from offshore engine combustion during routine operations would be accomplished through existing regulations and the development of new control emission technology.*Threatened and Endangered Species:* Because the proposed CPA lease sales do not in and of themselves make any irreversible or irretrievable commitment of resources that would foreclose the development or implementation of any reasonable and prudent measures to comply with the Endangered Species Act, BOEM may proceed with publication of this Supplemental EIS and finalize a decision among these alternatives even if consultation is not complete, consistent with section 7(d) of the ESA (also refer to **Chapter 5.7**). Irreversible loss of individuals that are ESA-listed species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

Nonendangered and Nonthreatened Marine Mammals: Unavoidable adverse impacts to nonendangered and nonthreatened marine mammals would be those that also affect endangered and threatened marine mammal species. Routine operation impacts (such as seismic surveys, water quality and habitat degradation, helicopter disturbance, vessel collision, and discarded trash and debris) would be negligible or minor to a population, but they could be lethal to individuals as in the case of a vessel collision. A large oil spill would temporarily degrade habitat if spilled oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals contact free-ranging pods or spawning grounds.

Coastal and Marine Birds: Unavoidable adverse impacts from routine operations on coastal birds could result from helicopter and OCS service-vessel traffic, facility lighting, and floating trash and debris. Marine birds could be affected by noise, platform lighting, aircraft disturbances, and trash and debris associated with offshore activities. Cross-Gulf migrating species could be affected by lighted platforms, helicopter and vessel traffic, and floating trash and debris. If a large oil spill occurs and contacts coastal or marine bird habitats, some birds could experience lethal and sublethal impacts from oiling, and birds feeding or resting in the water could be oiled and die. Coastal birds coming into contact with oil may migrate more deeply into marsh habitats, out of reach from spill responders seeking to count them or collect them for rehabilitation. Oil spills and oil-spill cleanup activities could also affect the food species for coastal, marine, and migratory bird species. Depending on the time of year, large oil spills could decrease the nesting success of species that concentrate nests in coastal environments due to direct effects of the spill and also disruption from oil-spill cleanup activities.

Fish Resources, Commercial Fisheries, and Recreational Fishing: Unavoidable adverse impacts from routine operations are loss of open ocean or bottom areas desired for fishing by the presence or construction of OCS oil- and gas-related facilities and pipelines. Loss of gear could occur from bottom obstructions around platforms and subsea production systems. Routine discharges from vessels and platforms are minor given the available area for fish habitat. If a large oil spill occurs, the oil, dispersant chemicals, or emulsions of oil droplets and dispersant chemicals could temporarily displace mobile fish species on a population or local scale. There could also be impacts on prey and sublethal effects on fish. It is unlikely that fishermen would want, or be permitted, to harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species, rendering them unmarketable.

Recreational Beaches: Unavoidable adverse impacts from routine operations may result in the accidental loss overboard of some floatable debris that may eventually come ashore on frequented recreational beaches. A large oil spill could make landfall on recreational beaches, leading to local or regional economic losses and stigma effects, causing potential users to avoid the area after acute impacts have been removed. Some recreational beaches become temporarily soiled by weathered crude oil, and tarballs may come ashore long after stranded oil has been cleaned from shoreline areas.

Economic Activity: Net economic, political, and social benefits accrue from the production of hydrocarbon resources. Once these benefits become routine, unavoidable adverse impacts from routine operations follow trends in supply and demand based on the commodity prices for oil, gas, and refined hydrocarbon products. Declines in oil and gas prices can lead to activity ramp downs by operators until prices rise. A large oil spill would cause temporary increases in economic activity associated with spill-response activity. An increase in economic activity from the response to a large spill could be offset by temporary work stoppages that are associated with spill-cause investigations and would involve a transfer or displacement of demand to different skill sets. An oil spill could also negatively impact industries such as tourism and fishing. Routine operations affected by new regulations that are incremental would not have much effect on the baseline of economic activity; however, temporary work stoppages or the introduction of several new requirements at one time, which are costly to implement, could cause a drop-off of activity as operators adjust to new expectations or use the opportunity to move resources to other basins where they have interests.

Archaeological Resources: Unavoidable adverse impacts from routine operations could lead to the loss of unique or significant archaeological information if unrecognized at the time an area is disturbed. 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. A large oil spill that makes landfall on or near protected archaeological landmarks could cause temporary aesthetic or cosmetic impacts until the oil is cleaned or degrades.

4.3. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible or irretrievable commitment of resources refers 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 irretrievable loss of wetlands and associated biological resources could occur if wetlands are permanently lost because of impacts caused by dredging and construction activities that displace existing wetlands or from oil spills severe enough to cause permanent die-back of vegetation and conversion to open water. Construction and emplacement of onshore pipelines in coastal wetlands displace coastal wetlands in disturbed areas that are then subject to indirect impacts like saltwater intrusion or erosion of the marsh soils along navigation channels and canals. Ongoing natural and anthropogenic processes in the coastal zone, only one of which is OCS oil- and gas-related activity, can result in direct and indirect loss of wetlands. Natural losses as a consequence of the coastal area becoming hydrologically isolated from the Mississippi River that built it, sea-level rise, and subsidence of the delta platform in the absence of new sediment added to the delta plain appear to be much more dominant processes impacting coastal wetlands.

Sensitive Nearshore and Offshore Biological Resources: An irreversible loss or degradation of ecological habitat caused by cumulative activity tends to be incremental over the short term. Irretrievable loss may not occur unless or until a critical threshold is reached. It can be difficult or impossible to identify when that threshold is, or would be, reached. 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.

Threatened and Endangered Species: Irreversible loss of individuals that are protected species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

Fish Resources and Commercial Fisheries: Irreversible loss of fish and coral resources, including commercial and recreational species, are caused by structure removal using explosives. Fish in proximity to an underwater explosion can be killed. Without the structure to serve as habitat area, sessile, attached invertebrates and the fish that live among them are absent. Removing structures eliminates these special and local habitats and the organisms living there, including such valuable species as red snapper.

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: Impacts on recreational beaches from a large oil spill may, at the time, seem irreversible, but the impacts are generally temporary. Beaches fouled by a large oil spill would be temporarily unavailable to the people who would otherwise frequent them, but only during the period between landfall and cleanup of the oil, followed by an indefinite lag period during which stigma effects recede from public consciousness.

Archaeological Resources: Irreversible loss of a prehistoric or historic archaeological resource can occur if bottom-disturbing activity takes place without the surveys, where required, to demonstrate its absence before work proceeds. A resource can be completely destroyed, severely damaged, or the scientific context badly impaired by well drilling, subsea completions, and platform and pipeline installation, or sand borrowing.

Oil and Gas Development: Leasing and subsequent development and extraction of hydrocarbons as a result of a CPA proposed action represents an irreversible and irretrievable commitment by the removal and consumption of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of a CPA proposed action is presented in **Table 3-1**.

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 and work place safety and environmental protection. Nevertheless, some loss of human and animal life may be inevitable from unpredictable and unexpected acts of man and nature (i.e., unavoidable accidents, accidents caused by human negligence or misinterpretation, human error, willful noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal, can kill sea life in proximity to explosive charges or by removal of the structure that served as the framework for invertebrates living on it and the fish that lived with it.

4.4. RELATIONSHIP BETWEEN THE SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term effects on various components of the environment in the vicinity of a CPA proposed action are related to long-term effects and the maintenance and enhancement of long-term productivity.

Short-Term Use

Short-term refers to the total duration of oil and gas exploration and production activities. Extraction and consumption of offshore oil and natural gas is a short-term benefit. Discovering and producing domestic oil and gas now reduces the Nation's dependency on foreign imports. Depleting a nonrenewable resource now removes these domestic resources from being available for future use. The production of offshore oil and natural gas as a result of a CPA proposed action would provide short-term energy, and as it delays the increase in the Nation's dependency on foreign imports, it can also allow additional time for ramp-up and development of long-term renewable energy sources or substitutes for nonrenewable oil and gas. Economic, political, and social benefits would accrue from the availability of these natural resources.

The principle short-term use of the leased areas in the Gulf of Mexico would be for the production of 0.460-0.894 BBO and 1.939-3.903 Tcf of gas from a typical CPA proposed action. The cumulative impacts scenario in this Supplemental EIS extends approximately from 2012 to 2051. The 40-year time period is used because it is the approximate longest life span of activities conducted on an individual lease. The 40 years following a proposed CPA lease sale is the period of time during which the activities and impacting factors that follow as a consequence of a proposed CPA lease sale would be influencing the environment.

The specific impacts of a CPA proposed action vary in kind, intensity, and duration according to the activities occurring at any given time (**Chapter 3**). 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 CPA 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 or a spill. Platform removal is also a short-term activity with localized impacts, including removal of the habitat for encrusting invertebrates and fish living among them. Many of the effects on physical, biological, and socioeconomic resources discussed in **Chapter 4.1** are considered to be short term (being greatest during the construction, exploration, and early production phases). These impacts would be further reduced by the mitigating measures discussed in **Chapter 2.2.2**.

The OCS development off Texas, Louisiana, Mississippi, and Alabama has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and specialized recreational fishing equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. A CPA proposed action could increase these incidental benefits of offshore development. Offshore fishing and diving has gradually increased in the past three decades, with offshore structures and platforms becoming 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.

The short-term exploitation of hydrocarbons for the OCS Program in the Gulf of Mexico may have long-term impacts on biologically sensitive coastal and offshore resources and areas if a large oil spill occurs. A spill and spill-response activity could temporarily interfere with commercial and recreational fishing, beach use, and tourism in the area where the spill makes landfall and in a wider area based on stigma effects. 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 (Chapter 4.2.1.23.1 of the 2012-2017 WPA/CPA Multisale EIS and WPA 233/CPA 231 Supplemental EIS).

Relationship to Long-Term Productivity

Long-term refers to an indefinite period beyond the termination of oil and gas production. Over a period of time after peak oil production has occurred in the Gulf of Mexico, a gradual easing of the specific impacts caused by oil and gas exploration and production would occur as the productive reservoirs in the Gulf have been discovered and produced, and have become depleted. The Oil Drum (2009) showed a graphic demonstrating that peak oil production in the Gulf occurred in June 2002 at 1.73 MMbbl/day. Whether or not this date is correct can only be known in hindsight and only after a period of years while production continues. At this time, however, the trend is fairly convincing (The Oil Drum, 2009). There is disagreement on what future production trends may be in the Gulf of Mexico after several operators, BP among them, announced discoveries over the last 5 years (*Oil and Gas Journal*, 2009) in the Lower Tertiary in ultra-deepwater (>5,000 ft; 1,524 m) with large projected reserves. These claims are as yet unproven and there are questions as to the difficulties that may be encountered producing these prospects because of their geologic age; burial depth and high-temperature, high-pressure in-situ conditions; lateral continuity of reservoirs; and the challenges of producing from ultra-deepwater water depths.

The Gulf of Mexico’s large marine ecosystem is considered a Class II, moderately productive ecosystem (mean phytoplankton primary production 150-300 gChlorophyll a/m^2-yr [The Encyclopedia of Earth, 2008]) based on Sea-viewing Wide Field-of-view Sensor (SeaWiFS) global primary productivity estimates (USDOC, NASA, 2003). After the completion of oil and gas production, a gradual ramp-down to economic conditions without oil and gas activity would be experienced, while the marine environment is generally expected to remain at or return to its normal long-term productivity levels that, in recent years, has been described as stressed (The Encyclopedia of Earth, 2008). The Gulf of Mexico’s large marine ecosystem shows signs of ecosystem stress in bays, estuaries, and coastal regions (Birkett and Rapport, 1999). There is shoreline alteration, pollutant discharge, oil and gas development, and nutrient loading. The overall condition for the U.S. section of this large marine ecosystem, according to USEPA’s seven primary indicators (Jackson et al., 2000), is good dissolved oxygen, fair water quality, poor coastal wetlands, poor eutrophic condition, and poor sediment, benthos, and fish tissue (The Encyclopedia of Earth, 2008).

To help sustain the long-term productivity of the Gulf of Mexico ecosystem, the OCS Program provides structures to use as site-specific artificial reefs and fish-attracting devices for the benefit of commercial and recreational fishermen and to sport divers and spear fishers. Additionally, the OCS Program continues to improve the knowledge and mitigation practices used in offshore development. Approximately 10 percent of the oil and gas structures removed from the OCS are eventually used for State artificial reef programs.

CHAPTER 5

CONSULTATION AND COORDINATION

5. CONSULTATION AND COORDINATION

5.1. DEVELOPMENT OF THE PROPOSED ACTIONS

This Supplemental EIS addresses three proposed Federal OCS oil and gas lease sales, i.e., Lease Sales 235, 241, and 247 in the CPA of the Gulf of Mexico OCS, as scheduled in the Five-Year Program (USDOI, BOEM, 2012a). BOEM conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for the proposed CPA lease sales and this Supplemental EIS. Key agencies and organizations included the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Marine Fisheries Service (NMFS), U.S. 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 A SUPPLEMENTAL EIS AND CALL FOR INFORMATION

On August 23, 2013, the Notice of Intent to Prepare a Supplemental EIS (NOI) for the proposed CPA lease sales was published in the *Federal Register* (2013b). Additional public notices were distributed via the U.S. Postal Service, and the Internet. A 30-day comment period was provided; it closed on September 23, 2013. Federal, State, and local governments, along with other interested parties, were invited to send written comments to the Gulf of Mexico OCS Region on the scope of the Supplemental EIS. BOEM received eleven comment letters in response to the NOI. These comments are summarized below in **Chapter 5.3.1**. Public scoping meetings were held in Louisiana, Mississippi, and Alabama on the following dates and at the times and locations indicated below:

Monday, September 9, 2013
6:30 p.m. CDT
Courtyard by Marriott
Gulfport Beachfront MS Hotel
1600 East Beach Boulevard
Gulfport, Mississippi 39501
5 registered attendees
2 speakers

Tuesday, September 10, 2013
6:30 p.m. CDT
Hilton Garden Inn Mobile West
828 West I-65 Service Road South
Mobile, Alabama 36609
2 registered attendees
0 speakers

Wednesday, September 12, 2012
1:00 p.m. CDT
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123
1 registered attendee
0 speakers

On July 9, 2012, the Call for Information (Call) for proposed CPA Lease Sales 231, 235, 241, and 247 was published in the *Federal Register* (2012c). The comment period closed on August 8, 2012. This Agency received two comment letters in response to the Call. These comments are summarized below in **Chapter 5.3.2**.

5.3. DEVELOPMENT OF THE DRAFT SUPPLEMENTAL EIS

Scoping for the Draft Supplemental 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 BOEM an opportunity to update the Gulf of Mexico OCS Region's environmental and socioeconomic information base.

5.3.1. Summary of Scoping Comments

Eleven comments were received in response to the NOI from Federal agencies, State government, interested groups, industry, and the general public on the scope of the Supplemental EIS, significant issues that should be addressed, alternatives that should be considered, and mitigating measures. All scoping comments received, which were appropriate for a lease sale NEPA document, were considered in the preparation of the Draft Supplemental EIS. Comments received included the following:

- BOEM must oversee oil and gas development in a way that protects Alabama from future incidents; BOEM must constantly examine their practices and procedures to improve their ability to provide safe offshore operations; Alabama understands the importance of the oil and gas industry to the Nation and supports its safe production offshore provided those developments comply with applicable Alabama laws, rules, and regulations, and is in compliance with Alabama's Coastal Zone Management Plan; Alabama asks for protection of live bottom, pinnacle reefs, chemosynthetic communities, and other sensitive areas (including archaeological sites); Alabama opposes leases within 15 mi (24 km) south of Baldwin County; and Alabama requests just and equitable revenue sharing under the Gulf of Mexico Energy Security Act and calls for new legislation for additional revenue sharing;
- the Gulf is contaminated enough so leave it alone;
- no more drilling; opposes lease sales; BOEM cannot monitor the oil industry; oil companies do not care about regulations and will continue to destroy our lands;
- there is a way to produce oil and gas in the Gulf near the barrier islands without permanent derricks and platforms; use dredge material to rebuild barrier islands that can hold, protect, and hide wells; and use horizontal drilling techniques;
- BOEM must focus EIS analyses on currently available, new information and should not speculate on future results from ongoing studies. BOEM should also take into consideration the new safety and regulatory improvements since the *Deepwater Horizon* explosion, oil spill, and response as a part of the new information analyzed. Suggest that this Supplemental EIS be designed specifically for use as a tiering document for future environmental reviews. Data from the best-available, peer-reviewed scientific literature should be the basis of environmental analyses, and not speculation;
- BOEM and BSEE must evaluate regulatory oversight, safety procedures, and new technologies in light of recent accidents around the world to ensure safe oil and gas operations on the United States' OCS;
- ". . . BOEM should suspend preparation of the SEIS and establish a fundamental revision to the planning, oversight, and approval process for offshore drilling activities. It should also allow for site assessment and permitting activities for renewable energy in the Gulf of Mexico. . . . BOEM must fully consider how the impacts of the DWH Spill changed the ecological baselines of the Gulf of Mexico, regardless of the amount of time it takes to attain this information. . . . BOEM must not approve any new activities in the CPA until these actions are complete";
- the USEPA provided guidance on topics including the following: statement of purpose and need; alternatives analysis; affected environment; environmental consequences; Marine Protection, Research and Sanctuaries Act; oil management and spill analysis; discharge of dredged or fill materials; water quality; biological resources, habitat, and wildlife; air quality; greenhouse gases; climate change; hazardous materials; hazardous waste and solid waste; National Historic Preservation Act and Executive Order 13007; environmental justice and impacted communities; Tribal consultation; children's health and safety; indirect and cumulative impacts; mitigation and monitoring; and additional non-OCS activities;

- Louisiana supports continued expansion of OCS oil and gas development, but requests that BOEM adequately address the cumulative, secondary, and indirect impacts of these activities and discuss compensatory mitigation for the impacts;
- the Consumer Energy Alliance supports the proposed action for the socioeconomic and national security benefits, and urges BOEM to reject requests to delay or prohibit leasing in the CPA; and
- BOEM should expand leasing to all areas of the Eastern Planning Area due to the socioeconomic benefits for the Nation and Gulf Coast.

5.3.2. Summary of Comments Received in Response to the Call for Information

In response to the Call, BOEM received two comment letters: one letter from the Louisiana Department of Natural Resources and one letter from the American Petroleum Institute. The Louisiana Department of Natural Resources hopes that BOEM will be more attentive to the State of Louisiana’s comments during the prelease planning phase, believes that a better appraisal of coastal effects is necessary, and believes that BOEM must more efficiently revisit reviews of earlier OCS lease sales to determine whether the models and predictive techniques used were accurate. The American Petroleum Institute states that annual, predictable lease sales in these planning areas are needed to help ensure continued offshore exploration and production in the future because production from lease sales will take many years to develop. The American Petroleum Institute further encourages BOEM to pursue legislation that will allow the entry into force of the “Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico” (Agreement). This Agreement will govern the development of reservoirs of petroleum and natural gas straddling the U.S.-Mexico maritime and continental shelf boundary in the Gulf of Mexico. Although the Agreement has received Congressional approval and the President’s signature, it has not yet entered into force. Please note that the United States and Mexico, by exchange of diplomatic notes on January 17, 2014, extended a treaty prohibition on exploration and development in the 1.4-nmi buffer zone until July 17, 2014, or the day the Agreement enters into force, whichever is sooner.

5.3.3. Additional Scoping Opportunities

Although the scoping process is formally initiated by the publication of the NOI and Call, scoping efforts and other coordination meetings have proceeded and will continue to proceed throughout this NEPA process. The Gulf of Mexico OCS Region’s Information Transfer Meetings provide an opportunity for BOEM’s analysts to attend technical presentations related to OCS Program activities and to meet with representatives from Federal, State, and local agencies; industry; BOEM contractors; and academia. Scoping and coordination opportunities were also available during BOEM’s requests for information, comments, input, and review of its other NEPA documents, included the following:

- scoping and comments on the Five-Year Program EIS;
- requests for comments on the 2012-2017 WPA/CPA Multisale EIS; and
- scoping and comments on the WPA 233/CPA 231 Supplemental EIS.

5.3.4. Cooperating Agency

According to Part 516 of the DOI Departmental Manual, BOEM 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. BOEM must also consider any requests by eligible government entities to participate as a cooperating agency with respect to a particular EIS, and then to either accept or deny such requests.

The NOI, which was published on August 23, 2013, included an invitation to other Federal agencies and State, Tribal, and local governments to consider becoming cooperating agencies in the preparation of this EIS. No Federal agencies or State, Tribal, or local governments requested to participate as a cooperating agency.

5.4. DISTRIBUTION OF THE DRAFT SUPPLEMENTAL EIS FOR REVIEW AND COMMENT

BOEM sent copies of the Draft Supplemental EIS to the government, public, and private agencies and groups listed below. Local libraries along the Gulf Coast were provided copies of this document; a list of these libraries is available on BOEM's Internet website at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx.

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 Oceanic and Atmospheric Administration
- National Marine Fisheries Service

Department of Defense
- Corps of Engineers
- Department of the Air Force
- Department of the Army
- Corps of Engineers
- Department of the Navy
  - Naval Mine and Anti-Submarine Warfare Command

Department of Energy
- Strategic Petroleum Reserve PMD

Department of Homeland Security
- U.S. Coast Guard

Department of State
- Bureau of Oceans and International Environmental and Scientific Affairs

Department of the Interior
- Bureau of Ocean Energy Management
- Fish and Wildlife Service
- Geological Survey
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of Transportation
- Pipeline and Hazardous Materials Safety Administration
- 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 Conservation and Natural Resources
- Department of Environmental Management
- 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
- City of Gulf Breeze
- City of Panama City
- City of Pensacola
- Department of Economic Opportunity
- Department of Environmental Protection
- Department of State Archives, History and Records Management
- Escambia County
- Florida Coastal Zone Management Office
- Sarasota County Coastal Resources
- State Legislature Natural Resources and Conservation Committee
- State Legislature Natural Resources Committee
- West Florida Regional Planning Council

Louisiana
- Governor's Office
- City of Grand Isle
- City of Morgan City
- City of New Orleans
- Department of Culture, Recreation, and Tourism
- Department of Environmental Quality
- Department of Natural Resources

Department of Transportation and Development
Department of Wildlife and Fisheries
Houma-Terrebonne Chamber of Commerce
Jefferson Parish Director
Jefferson Parish President
Lafourche Parish CZM
Lafourche Parish Water District #1
Louisiana Geological Survey
South Lafourche Levee District
St. Bernard Planning Commission
State House of Representatives, Natural Resources Committee
State Legislature, Natural Resources Committee

Mississippi

Governor's Office
City of Gulfport
Department of Archives and History
Department of Natural Resources
Department of Wildlife Conservation
Mississippi Development Authority
State Legislature Oil, Gas, and Other Minerals Committee

Industry

Alabama Petroleum Council
American Petroleum Institute
Area Energy LLC
Baker Atlas
Bellwether Group
B-J Services Co
BP Amoco
Chevron U.S.A. Inc.
Coastal Conservation Association
Coastal Environments, Inc.
Continental Shelf Associates, Inc.
Dominion Exploration & Production, Inc.
Ecological Associates, Inc.
Ecology and Environment
Energy Partners, Ltd.
EOG Resources, Inc.
Exxon Mobil Production Company
Freeport-McMoRan, Inc.
Fugro Geo Services, Inc.
Gulf Environmental Associates
Gulf of Mexico Newsletter
Horizon Marine, Inc.
Industrial Vehicles International, Inc.
International Association of Geophysical Contractors
J. Connor Consultants
John Chance Land Surveys, Inc.
Marine Safety Office
Midstream Fuel Service
Murphy Exploration & Production
Newfield Exploration Company
Petrobras America, Inc.
PPG Industries, Inc.
Propane Market Strategy Newsletter
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
The Washington Post
Triton Engineering Services Co.
W & T Offshore, Inc.
WEAR-TV

Special Interest Groups

Alabama Oil & Gas Board
Alabama Wildlife Federation
American Cetacean Society
Apalachee Regional Planning Council
Audubon of Florida
Audubon Louisiana Nature Center
Capital Region Planning Commission
Center for Marine Conservation
Clean Gulf Associates
Coalition to Restore Coastal Louisiana
Coastal Conservation Association
Concerned Shrimpers of America
Earthjustice
Gulf and South Atlantic Fisheries Foundation, Inc.
Gulf Coast Environmental Defense
Gulf Restoration Network
Houma-Terrebonne Chamber of Commerce
Izaak Walton League of America, Inc.
JOC Venture
LA 1 Coalition, Inc.
Louisiana Wildlife Federation
Marine Mammal Commission
Mission Enhancement Office
Mobile Area Chamber of Commerce
Mobile Bay National Estuary Program
Natural Resources Defense Council
Nature Conservancy
Offshore Operators Committee
Organized Fishermen of Florida
Population Connection
Portersville Revival Group

Restore or Retreat
Roffers Ocean Fishing Forecast Service

Ports/Docks

Alabama
Alabama State Port Authority
Port of Mobile

Louisiana
Abbeville Harbor and Terminal District
Grand Isle Port Commission
Greater Baton Rouge Port Commission
Greater Lafourche Port Commission
Lake Charles Harbor and Terminal District
Plaquemines Port, Harbor and Terminal District
Port of Baton Rouge
Port of Iberia District
Port of New Orleans
Twin Parish Port Commission
St. Bernard Port, Harbor and Terminal District
West Cameron Port Commission

Mississippi
Greenville Port Commission
Mississippi State Port Authority
Port of Gulfport

Educational Institutions/Research Laboratories

Dauphin Island Sea Laboratory
Foley Elementary School
Gulf Coast Research Laboratory
Jackson State University
Louisiana Sea Grant College Program
Louisiana State University
Louisiana Tech University
Louisiana Universities Marine Consortium
Loyola University
McNeese State University
Mississippi-Alabama Sea Grant Consortium
Mississippi State University
Mote Marine Laboratory
Nicholls State University
Pensacola Junior College
Tulane University
University of Alabama
University of Florida
University of Miami
University of New Orleans
University of South Alabama
University of South Florida
University of Southern Mississippi
University of Texas at Arlington
University of Texas at Austin
University of Texas Law School
University of Texas Libraries
University of West Florida

5.5. COASTAL ZONE MANAGEMENT ACT

If a Federal agency's activities or development projects within or outside of the coastal zone will have reasonably foreseeable coastal effects in the coastal zone, then the activity is subject to a Federal Consistency Determination (CD). A consistency review will be performed pursuant to the Coastal Zone Management Act (CZMA) and CD's will be prepared for the each CZMA State prior to each of the proposed CPA lease sales. To prepare the CD's, BOEM reviews each CZMA State's Coastal Management Plan (CMP) and analyzes the potential impacts as outlined in this Supplemental EIS, new information, and applicable studies as they pertain to the enforceable policies of each CMP. The CZMA requires that Federal actions that are reasonably likely to affect any land or water use or natural resource of the coastal zone be "consistent to the maximum extent practicable" with relevant enforceable policies of the State's federally approved coastal management program (15 CFR part 930 subpart C).

Based on these and other analyses, BOEM's Director makes an assessment of consistency, which is then sent to each State with the Proposed Notice of Sale. If a State concurs, BOEM can proceed with the lease sale. A State's concurrence may be presumed when a State does not provide a response within the 60-day review period. A State may request an extension of time to review the CD within the 60-day period, which the Federal agency shall approve for an extension of 15 days or less. If a State objects, it must do the following under the CZMA: (1) indicate how BOEM's prelease proposal is inconsistent with their CMP and suggest alternative measures to bring BOEM's proposal into consistency with their CMP; or (2) describe the need for additional information that would allow a determination of consistency. In the event of an objection, the Federal and State agencies should use the remaining portion of the 90-day review period to attempt to resolve their differences (15 CFR § 930.43(b)). At the end of the 90-day review period, the Federal agency shall not proceed with the activity over a State agency's objection unless the Federal agency concludes that, under the "consistent to the maximum extent practicable" standard described in 15 CFR § 930.32, consistency with the enforceable policies of the CMP is prohibited by existing law applicable to the Federal agency and the Federal agency has clearly described, in writing, to the State agency the legal impediments to full consistency; or, the Federal agency has concluded that its proposed action is fully consistent with the enforceable policies of the CMP, though the State agency objects. Unlike the consistency process for specific OCS plans and permits, there is no procedure for administrative appeal to the Secretary of Commerce for a Federal CD for prelease activities. In the event that there is a serious disagreement between BOEM and a State, either agency may request mediation. Mediation is voluntary, and the Department of Commerce would serve as the mediator. Whether there is mediation or not, the final CD is made by DOI, and it is the final administrative action for the prelease consistency process. Each Gulf State's CMP is described in Appendix F of the 2012-2017 WPA/CPA Multisale EIS.

5.6. ENDANGERED SPECIES ACT

The Endangered Species Act of 1973 (ESA) (16 U.S.C. §§ 1631 *et seq.*) establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. BOEM is currently in consultation with NMFS and FWS regarding the OCS oil and gas program in the Gulf of Mexico, including as it relates to the CPA proposed actions. BOEM is acting as the lead agency in the ongoing consultation, with BSEE's assistance and involvement. The programmatic consultation was expanded in scope after the reinitiation of consultation by BOEM following the *Deepwater Horizon* explosion and oil spill, and it will include both existing and future OCS oil and gas leases in the Gulf of Mexico through 2022. This consultation also considers any changes in baseline environmental conditions following the *Deepwater Horizon* explosion, oil spill, and response. The programmatic consultation will also include postlease activities associated with OCS oil and gas activities in the Gulf of Mexico, including G&G and decommissioning activities. While the programmatic Biological Opinion is in development, BOEM and NMFS have agreed to interim consultations on postlease approvals.

With consultation ongoing, BOEM and BSEE will continue to comply with all reasonable and prudent measures and the terms and conditions under the existing consultations, along with implementing the current BOEM- and BSEE-required mitigation, monitoring, and reporting requirements. Based on the most recent and best available information at the time, BOEM and BSEE will also continue to closely evaluate and assess risks to listed species and designated critical habitat in upcoming environmental compliance documentation under NEPA and other statutes.

5.7. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

Pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act, Federal agencies are required to consult with NMFS on any action that may result in adverse effects to essential fish habitat (EFH). The NMFS published the final rule implementing the EFH provisions of the Magnuson-Stevens Fisheries Conservation and Management Act (50 CFR part 600) on January 17, 2002. Certain OCS activities authorized by BOEM may result in adverse effects to EFH, and therefore, require EFH consultation.

Following the *Deepwater Horizon* explosion, oil spill, and response, NMFS requested a comprehensive review of the existing EFH consultation in a response letter dated September 24, 2010. In light of this request, Regional staff of BOEM and NMFS agreed on procedures that would incorporate a new programmatic EFH consultation into each prepared Five-Year Program EIS and that began with the 2012-2017 Five-Year Program. BOEM has an EFH Assessment (Appendix D of the 2012-2017 WPA/CPA Multisale EIS) that describes the OCS proposed activities, analyzes the effects of the proposed activities on EFH, and identifies proposed mitigating measures. The programmatic EFH consultation, which covers proposed CPA Lease Sales 235, 241, and 247 was initiated with the distribution and review of the 2012-2017 WPA/CPA Multisale EIS and with the subsequent written communications between BOEM and NMFS. These documents formalized the conservation recommendations put forth by NMFS and by BOEM's acceptance and response to these recommendations. While the necessary components of the EFH consultation are complete (as per BOEM's June 8, 2012, response letter to NMFS), there is ongoing coordination among NMFS, BOEM, and BSEE. This coordination includes annual reports from BOEM to NMFS, meetings with Regional staff, and discussions of mitigation and relevant topics. All agencies will continue to communicate for the duration of the Five-Year Program.

5.8. NATIONAL HISTORIC PRESERVATION ACT

In accordance with the National Historic Preservation Act (16 U.S.C. § 470 *et seq*.), Federal agencies are required to consider the effect of their undertakings on historic properties. The implementing regulations for Section 106 of the National Historical Preservation Act (16 U.S.C. § 470f), issued by the Advisory Council on Historic Preservation (16 CFR part 800), specify the required review process.

This Agency initiated a request for consultation on the 2012-2017 WPA/CPA Multisale EIS on November 12, 2010, via a formal letter. That letter was addressed to each of the affected Gulf Coast States and Tribal Nations, including the Alabama-Coushatta Tribes of Texas, Chitimacha Tribe of Louisiana, Choctaw Nation of Oklahoma, Coushatta Indian Tribe, Jena Band of Choctaw Indians, Miccosukee Indian Tribe of Florida, Mississippi Band of Choctaw Indians, Poarch Band of Creek Indians, Seminole Tribe of Florida, and Tunica-Biloxi Indian Tribe of Louisiana. A response timeline of 30 days was provided and three responses were received.

The State of Louisiana, in a letter to this Agency dated December 16, 2010, indicated that no known historic properties on State land or within State waters will be affected by this undertaking and that consultation regarding the CPA proposed actions is not necessary. The State of Alabama, in a letter to BOEM referencing proposed WPA Lease Sale 233 and proposed CPA Lease Sale 231 dated July 18, 2012, requested that a "Maritime Cultural Resource Assessment which meets the AHC [Alabama Historical Commission] standards should be conducted for any action within these sale blocks" and that the resulting report should be forwarded to their office for review and approval. Additional correspondence with the State of Alabama explained that cultural resource assessments are completed as part of BOEM's postlease requirements and that they are site specific and are completed prior to authorization or approval of all proposed oil and gas activities. When necessary, cultural resource reports are also forwarded to the appropriate State agency as part of the Section 106 consultation process. A subsequent letter from the State of Alabama, dated August 16, 2012, agreed with the proposed lease actions, provided that submerged cultural resources are addressed prior to disturbance, as outlined above.

The Seminole Tribe of Florida-Tribal Historic Preservation Officer (STOF-THPO) responded to this Agency's request for consultation on December 6, 2010. The STOF-THPO indicated that there was no objection to the proposed undertakings at this time. The STOF-THPO requested to review the impending remote-sensing survey reports that are to be conducted over the high-probability zones within the project area. Additionally, the STOF-THPO requested to be notified if cultural resources that are potentially ancestral or historically relevant to the Seminole Tribe of Florida are inadvertently discovered at any point during this process.

None of the above-referenced responses requested consultation. No further responses were received beyond the 30-day timeline and no requests for consultation were received. BOEM will continue to impose mitigating measures and monitoring and reporting requirements to ensure that historic properties are not affected by the proposed undertakings. BOEM will reinitiate the consultation process with the affected parties should such circumstances warrant further consultation.

CHAPTER 6

REFERENCES CITED

6. REFERENCES CITED

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Chapter 7

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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.

Annular preventer—A component of the pressure control system in the BOP that forms a seal in the annular space around any object in the wellbore or upon itself, enabling well control operations to commence.

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 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—The FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species, in response to formal consultation under Section 7 of the Endangered Species Act.

Block—A geographical area portrayed on official BOEM protraction diagrams or leasing maps that contains approximately 2,331 ha (9 mi^2).

Blowout—An uncontrolled flow of fluids below the mudline from appurtenances on a wellhead or from a wellbore.

Blowout preventer (BOP)—One of several valves installed at the wellhead to prevent the escape of pressure either in the annular space between the casing and drill pipe or in open hole (i.e., hole with no drill pipe) during drilling completion operations. Blowout preventers on jackup or platform rigs are located at the water's surface; on floating offshore rigs, BOP's are located on the seafloor.

Bottom kill—A wild well-control procedure involving the intersection of an uncontrolled well with a relief well for the purpose of pumping heavy mud or cement into the wild well to stanch the flow of oil or gas (the well-control strategy for the Macondo spill deployed in mid-July 2010 that resulted in the successful capping of the well).

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 several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches, and it 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 exploration 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 geologists 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 the 200-m (656-ft) water depth. The continental shelf is characterized by a gentle slope (about 0.1^{o}). This is different from the juridical 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^{o}-6^{o}).

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.

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 and Production Plan (DPP)—A document that must be prepared by the operator and submitted to BOEM for approval before any development and production activities are conducted on a lease or unit in any OCS area other than the western Gulf of Mexico.

Development Operations Coordination Document (DOCD)—A document that must be prepared by the operator and submitted to BOEM for approval before any development or production activities are conducted on a lease in the western Gulf of Mexico.

Development well—A well drilled to a known producing formation to extract oil or gas; a production well; distinguished from a wildcat or exploration 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.

Dispersant—A suite of chemicals and solvents used to break up an oil slick into small droplets, which increases the surface area of the oil and hastens the processes of weathering and microbial degradation.

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 (230 mi; 370 km) 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 BOEM for approval before any exploration or delineation drilling is conducted on a lease.

Exploration well—A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present.

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.

Kick—A deviation or imbalance, typically sudden or unexpected, between the downward pressure exerted by the drilling fluid and the upward pressure of in-situ formation fluids or gases.

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 and 30 CFR 550.

Lower marine riser package—The head assembly of a subsurface well at the point where the riser connects to a blowout preventer.

***Macondo*—**Prospect name given by BP to the Mississippi Canyon Block 252 exploration well that the *Deepwater Horizon* rig was drilling when a blowout occurred on April 20, 2010.

***Macondo* spill—**The name given to the oil spill that resulted from the explosion and sinking of the *Deepwater Horizon* rig from the period between April 24, 2010, when search and recovery vessels on site reported oil at the sea surface, and September 19, 2010, when the uncontrolled flow from the Macondo well was capped.

Marshes—Persistent, emergent, nonforested wetlands characterized by predominantly cordgrasses, rushes, and cattails.

Military warning area—An area established by the U.S. 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.

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.

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 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.

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.

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—A prospective subsurface area for hydrocarbon accumulation that is characterized by a particular structural style or depositional relationship.

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.

Ram—The main component of a blowout preventer designed to shear casing and tools in a wellbore or to seal an empty wellbore. A blind shear ram accomplishes the former and a blind ram the latter.

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 (e.g., 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.

Riser insertion tube tool—A "straw" and gasket assembly improvised during the Macondo spill response that was designed to siphon oil and gas from the broken riser of the *Deepwater Horizon* rig lying on the sea bottom (an early recovery strategy for the Macondo spill in May 2010).

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.

Shear ram—The component in a BOP that cuts, or shears, through the drill pipe and forms a seal against well pressure. Shear rams are used in floating offshore drilling operations to provide a quick method of moving the rig away from the hole when there is no time to trip the drill stem out of the hole.

Shoreline Cleanup and Assessment Team—The on-the-scene responders for post-spill shoreline protection who established priorities, standardized procedures, and terminology.

Spill of National Significance—Designation by the USEPA Administrator under 40 CFR 300.323 for discharges occurring in the inland zone and the Commandant of the U.S. Coast Guard for discharges occurring in the coastal zone, authorizing the appointment of a National Incident Commander for spill-response activity.

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.

Subsea isolation device—An emergency disconnection and reconnection assembly for the riser at the seafloor.

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). Harassments are 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 U.S. 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.

FIGURES

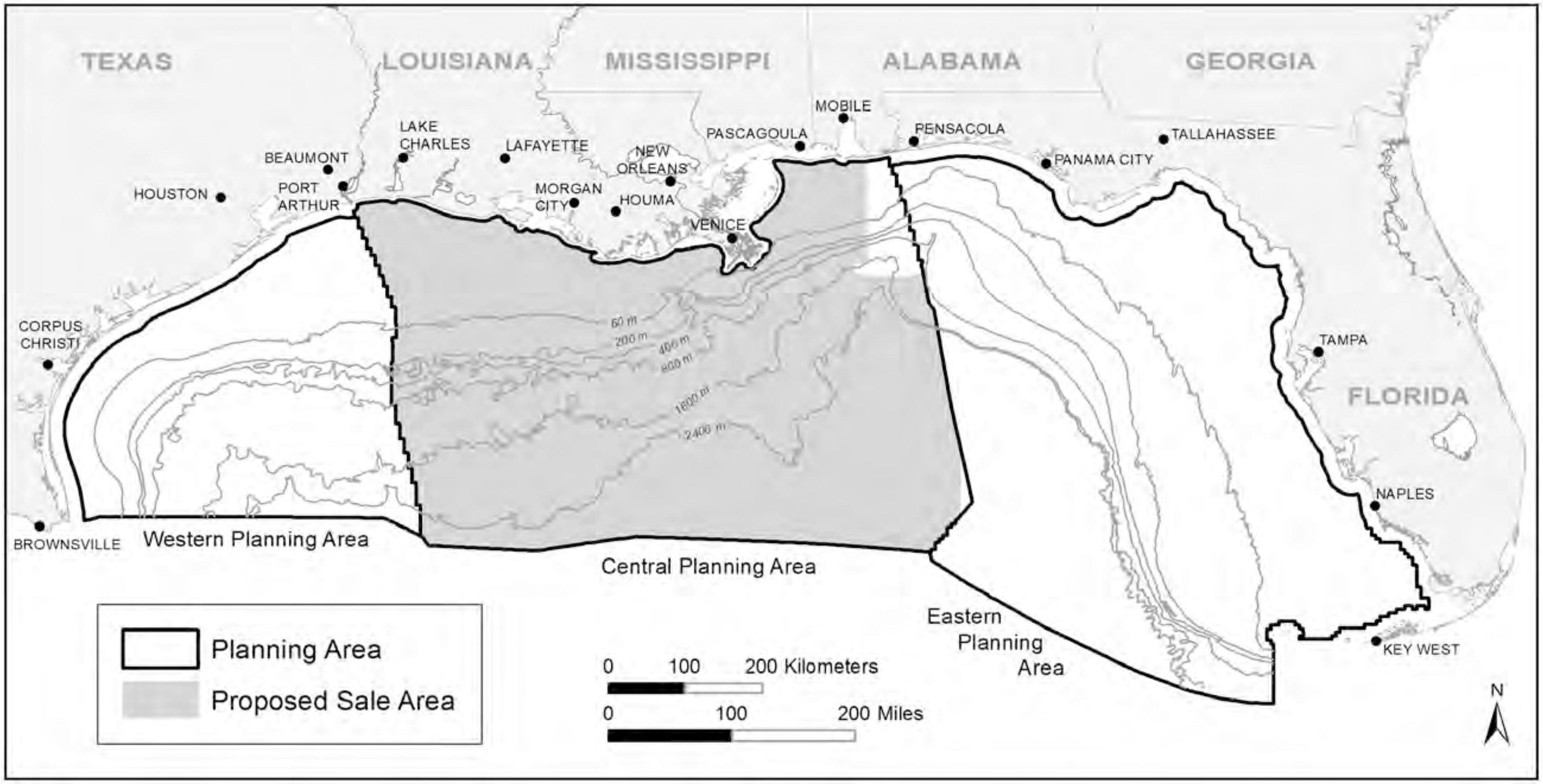

Figure 1-1. Gulf of Mexico Planning Areas, Proposed CPA Lease Sale Area, and Locations of Major Cities.

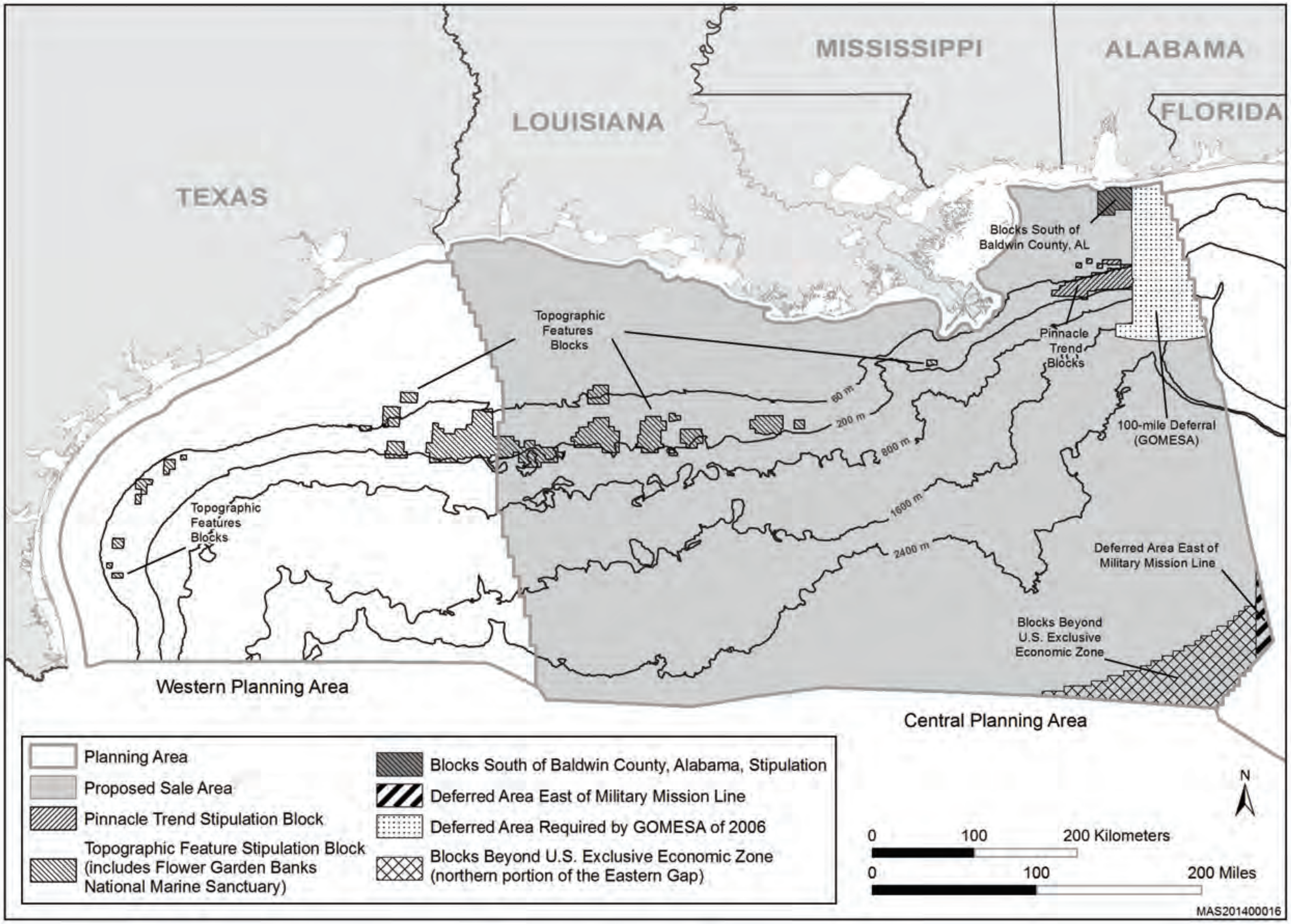

Figure 2-1. Location of Proposed Stipulations and Deferrals.

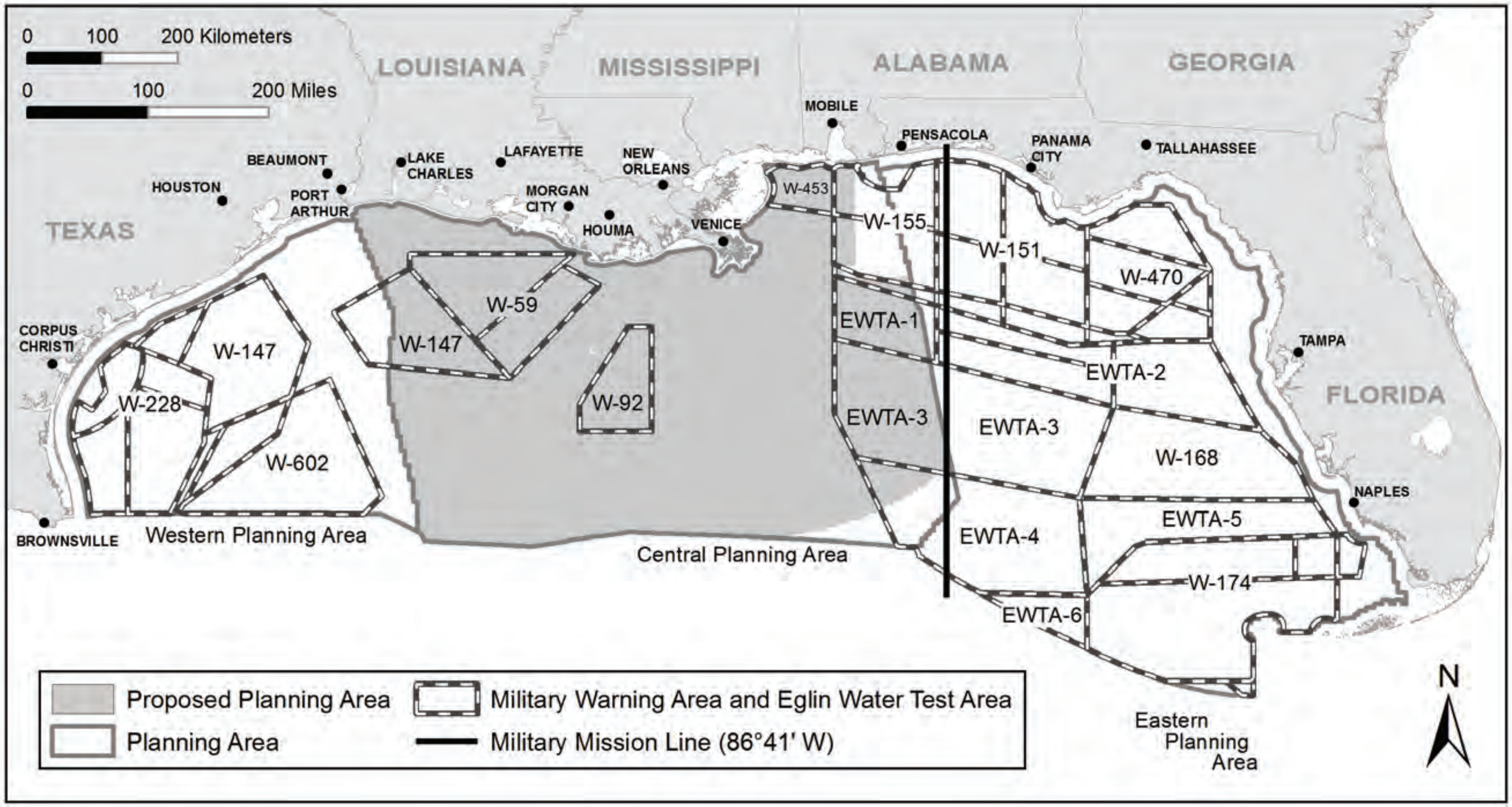

Figure 2-2. Military Warning Areas and Eglin Water Test Areas in the Gulf of Mexico

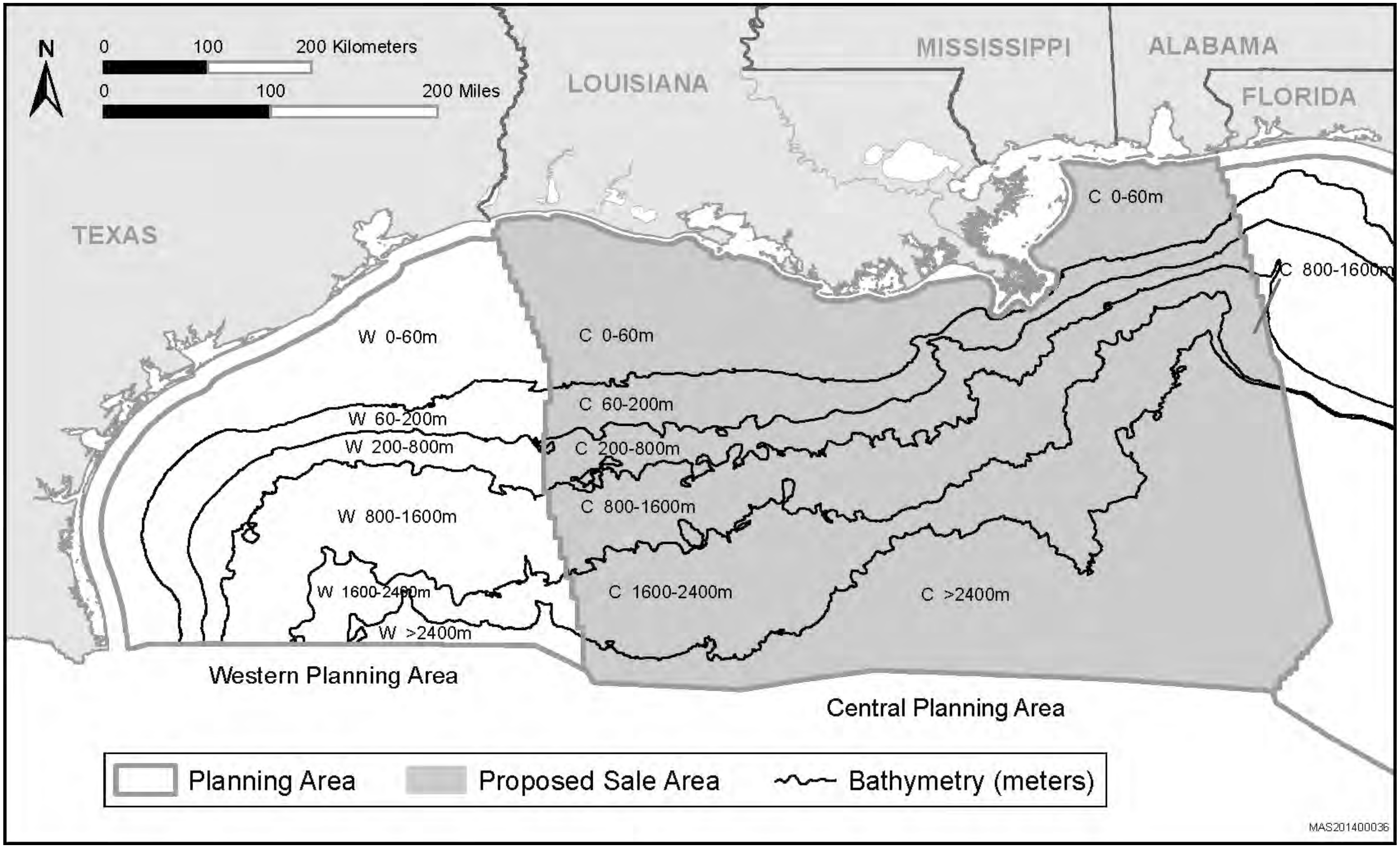

Figure 3-1. Offshore Subareas in the Gulf of Mexico.

TABLES

Table 3-1

Projected Oil and Gas in the Gulf of Mexico OCS

	Typical Lease Sale	OCS Cumulative (2012-2051)
Western Planning Area		
Reserve/Resource Production		
Oil (BBO)	0.116-0.200	2.510-3.696
Gas (Tcf)	0.538-0.938	12.539-18.434
Central Planning Area		
Reserve/Resource Production		
Oil (BBO)	0.460-0.894	15.825-21.733
Gas (Tcf)	1.939-3.903	63.347-92.691
Eastern Planning Area		
Reserve/Resource Production		
Oil (BBO)	0-0.071	0-0.211
Gas (Tcf)	0-0.162	0-0.502

BBO = billion barrels of oil.
Tcf = trillion cubic feet.

Table 3-2

Offshore Scenario Information Related to a Typical Lease Sale in the Central Planning Area

	Offshore Subareas[1]						Total CPA[2]
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	
Wells Drilled							
Exploration and Delineation Wells	62-121	24-46	21-42	15-29	18-36	28-55	168-329
Development and Production Wells	78-152	32-58	26-53	20-38	24-46	35-70	215-417
Producing Oil Wells	11-21	5-8	16-32	12-23	15-29	22-43	81-156
Producing Gas Wells	58-115	23-44	7-15	5-10	6-11	9-19	108-241
Production Structures							
Installed	28-54	3-6	1-2	1	1-2	1-2	35-67
Removed Using Explosives	18-36	2-4	0	0	0	0	20-40
Total Removed	25-49	3-5	1-2	1	1-2	1-2	32-61
Method of Transportation[3]							
Percent Piped	>99%	>99%	>99%	>99%	90->99%		93->99%
Percent Barged	<1%	0%	0%	0%	0%		<1%
Percent Tankered[4]	0%	0%	0%	0%	0-10%		0-6%
Length of Installed Pipelines (km)[5]	216-586	NA	NA	NA	NA	NA	628-1870
Service-Vessel Trips (1,000's round trips)	32-61	5-10	3-6	17-19	18-35	19-37	94-168
Helicopter Operations (1,000's operations)	557-1,470	63-163	21-54	14-36	21-54	21-54	696-1,815

[1] See **Figure 3-1**.

[2] Subareas totals may not add up to the planning area total because of rounding.

[3] 100% of gas is assumed to be piped.

[4] Tankering is forecasted to occur only in water depths >1,600 m (5,249 ft).

[5] Projected length of pipelines does not include length in State waters.

NA = not available.

Table 3-3

Offshore Scenario Information Related to OCS Program Activities
in the Gulf of Mexico (WPA, CPA, and EPA) for 2012-2051

	Offshore Subareas[1]						Total OCS[2]
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	
Wells Drilled							
Exploration and Delineation Wells	2,730-3,900	990-1,390	920-1,350	700-960	770-1,030	790-1,170	6,910-9,827
Development and Production Wells	3,380-4,820	1240-1,730	1130-1670	860-1,190	950-1,280	970-1,450	8,530-12,180
Producing Oil Wells	520-701	215-278	704-1030	574-783	663-873	620-915	3,296-4,605
Producing Gas Wells	2,510-3,629	885-1272	306-470	196-287	187-267	250-385	4,334-6,320
Production Structures							
Installed	1,210-1,720	110-160	26-40	25-30	32-33	32-38	1,435-2,026
Removed Using Explosives	796-1,139	69-104	3-4	0	0	0	868-1,247
Total Removed	1,090-1,560	100-150	24-34	20-28	23-30	22-33	1,279-1,837
Method of Transportation[3]							
Percent Piped	>99%	>99%	>99%	>99%	87->99%		92->99%
Percent Barged	<1%	0%	0%	0%	0%		<1%
Percent Tankered[4]	0%	0%	0%	0%	0-13%		0-7%
Length of Installed Pipelines (km)[5]	10,482-21,121	NA	NA	NA	NA	NA	30,428-69,749
Service-Vessel Trips (1,000's round trips)	1,366-1,942	196-280	111-162	466-619	584-626	587-719	3,310-4,382
Helicopter Operations (1,000's operations)	24,221-47,322	2,297-4,444	595-1,174	574-1,111	676-1,287	888-1,738	28,710-55,605

[1] See **Figure 3-1**.

[2] Subareas totals may not add up to the planning area total because of rounding.

[3] 100% of gas is assumed to be piped.

[4] Tankering is forecasted to occur only in water depths >1,600 m (5,249 ft).

[5] Projected length of pipelines does not include length in State waters.

NA = not available.

Table 3-4

Offshore Scenario Information Related to OCS Program Activities
in the Central Planning Area for 2012-2051

	Offshore Subareas[1]						Total CPA[2]
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	
Wells Drilled							
Exploration and Delineation Wells	2,230-3,160	820-1,160	700-1,030	540-730	700-940	730-1,090	5,720-8,110
Development and Production Wells	2,760-3,900	1,020-1,440	860-1,270	670-900	870-1,160	900-1,350	7,080-10,020
Producing Oil Wells	446-592	188-240	534-775	449-592	609-796	575-848	2,801-3,843
Producing Gas Wells	2,034-2,918	722-1,050	236-365	151-218	171-244	235-362	3,549-5,157
Production Structures							
Installed	990-1,390	90-130	20-30	20-25	30	30-35	1,180-1,640
Removed Using Explosives	650-920	55-83	2-3	0	0	0	707-1,006
Total Removed	890-1,260	80-120	18-26	16-21	21-27	21-31	1,046-1,485
Method of Transportation[3]							
Percent Piped	>99%	>99%	>99%	>99%	90->99%		93->99%
Percent Barged	<1%	0%	0%	0%	0%		>1%
Percent Tankered[4]	0%	0%	0%	0%	0-10%		0-6%
Length of Installed Pipelines (km)[5]	8,515-16,993	NA	NA	NA	NA	NA	25,204-57,177
Service-Vessel Trips (1,000's round trips)	1,117-1,570	161-230	85-126	371-469	546-569	549-663	2,829-3,627
Helicopter Operations (1,000's operations)	19,975-37,825	1,902-3,560	404-801	404-668	595-801	595-890	23,780-44,500

[1] See **Figure 3-1**.

[2] Subareas totals may not add up to the planning area total because of rounding.

[3] 100% of gas is assumed to be piped.

[4] Tankering is forecasted to occur only in water depths >1,600 m (5,249 ft).

[5] Projected length of pipelines does not include length in State waters.

NA = not available.

Table 3-5

Annual Volume of Produced Water Discharged by Depth
(millions of bbl)

Year	Shelf 0-60 m	Shelf 60-200 m	Slope 200-400 m	Deepwater 400-800 m	Deepwater 800-1,600 m	Ultra-Deepwater 1,601-2,400 m	Ultra-Deepwater >2,400 m	Total
2000	370.6	193.1	35.5	25.6	12.2	0.0	0.0	637.0
2001	364.2	185.2	35.0	32.0	16.6	0.0	0.0	633.0
2002	344.6	180.4	32.5	35.2	21.4	0.0	0.0	614.1
2003	359.4	182.9	31.2	39.0	35.5	0.2	0.0	648.2
2004	346.7	160.5	29.3	36.9	39.2	1.9	0.0	614.5
2005	270.1	113.5	23.1	33.5	43.0	5.8	0.0	489.0
2006	260.3	99.7	20.6	35.1	61.5	12.4	0.0	489.6
2007	307.0	139.4	22.2	40.0	70.3	15.5	0.1	594.5
2008	252.7	118.6	15.9	32.7	60.1	16.5	0.1	496.6
2009	263.9	108.3	19.9	39.2	65.3	25.0	0.1	521.7
2010	275.8	115.7	20.9	40.7	56.7	32.5	0.1	542.4
2011	271.3	116.9	20.5	39.7	67.7	32.2	0.1	548.4
2012	237.2	109.0	20.8	35.0	71.3	31.8	0.1	505.2

Source: Langley, official communication, 2013.

Table 3-6

Annual Summary of Number and Total Volume of Oil Spilled into the Gulf of Mexico, 2001-2011

Year	Number of Spills in the Gulf of Mexico	Volume of Spills in the Gulf of Mexico bbl (gallons)
2001	1,728	3,187 (133,872)
2002	733	2,535 (106,465)
2003	801	1,181 (49,617)
2004	908	760 (31,935)
2005	804	44,141 (1,853,919)
2006	868	2,947 (123,788)
2007	616	1,560 (65,511)
2008	523	355 (14,928)
2009	454	212 (8,898)
2010	455	4,928,389 (206,992,317)
2011	498	483 (20,276)

Note: The volume does not include oil spilled in rivers that enter the Gulf of Mexico. The reported spills include spills of crude and refined hydrocarbon products.

Source: U.S. Dept. of Homeland Security, CG, 2012.

Table 3-7

Waterway Length, Depth, Traffic, and Number of Trips for 2011

Waterway	Canal Length (km)	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
				Foreign	Domestic
Gulf Intracoastal Waterway (GIWW)					
Apalachee Bay to Panama City, FL	230	12	661	0	375
Panama City to Pensacola Bay, FL	187	12	1,812	0	1,306
Pensacola Bay, FL to Mobile Bay, AL	78	12	4,733	0	4,559
Mobile Bay, AL to New Orleans, LA	228	12, 14	17,295	0	21,952
Mississippi River, LA to Sabine River, TX	452	12, 10	63,384	0	52,470
Sabine River to Galveston, TX	143	12	59,132	0	33,756
Galveston to Corpus Christi, TX	322	11, 11, 10.2	25,561	0	19,333
Corpus Christi, TX to Mexican Border	226	10, 12, 7	2,212	0	1,641
Morgan City - Port Allen Route, LA	109	10	16,985	0	8,958
Florida Harbors, Channels, and Waterways					
Escambia and Conecuh Rivers, FL and AL; Escambia Bay, FL	12	10	2,273	0	2,789
La Grange Bayou, FL	3	9	249	0	81
Panama City Harbor, FL	9	34, 32, 10	2,142	313	879
Pensacola Harbor, FL	21	35, 33, 15, 14	752	33	336
St. Marks River, FL	61	9	62	0	28
Tampa Harbor, FL	140.5	45, 43, 34, 12, 9	31,408	1,190	822
Port Manatee, FL	5.1	40	3,724	17	231
Alabama Harbors, Channels, and Waterways					
Mobile Harbor, AL	71	47, 45, 40, 13-39	55,552	1,480	27,110
Theodore Ship Channel, AL	14	4	5,567	1,003	233
Mississippi Harbors, Channels, and Waterways					
Biloxi Harbor, MS	39	12, 10, 12	1,612	2	1,828
Gulfport Harbor, MS	34	30, 32, 8	2,151	2,119	1,899
Pascagoula Harbor, MS	18	40, 38, 38, 22, 12	36,863	637	3,216
Bayou Casotte, MS	2	38	36,557	558	3,019
Louisiana Harbors, Channels, and Waterways					
Atchafalaya River (Lower), LA	62	20	1,225	471	8,618
Barataria Bay Waterway, LA	71	16	156	0	3,056
Bayou Lafourche and Bayou Lafourche-Jump Waterway	85	28, 27, 27, 9	4,754	2,083	15,037
Bayou Little Caillou, LA	56	12	134	0	473
Bayou Teche, LA	181	3,3,4,7	733	0	576
Bayou Teche and Vermilion River, LA	88	8,11,9,8,5	613	23	2,627
Bayou Terrebonne, LA	61	10	174	0	681
Calcasieu River and Pass, LA	186	42, 42, 41-42, 36, 12, 7	54,247	1,558	61,847

Table 3-7. Waterway Length, Depth, Traffic, and Number of Trips for 2011 (continued)

Waterway	Canal Length (km)	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
				Foreign	Domestic
Louisiana Harbors, Channels, and Waterways (continued)					
Freshwater Bayou, LA	39	12	442	112	6,121
Houma Navigation Canal, LA	62	16, 15, 16	465	35	1,668
Mermentau River, LA	131	4, 7, 12, 10, 10, 9, 11, 6, 8, 4, 4, 7	321	0	1,298
Mermentau River, Bayou Nezpique, and Des Cannes, LA	122	9, 14, 10	394	0	499
Mississippi River, Baton Rouge LA to the Mouth of Passes	461	-	446,346	233,019	5,611
Port of New Orleans, LA	88	45, 30, 32, 36, 37, 12	77,175	25,881	1,789
Port of Baton Rouge, LA	152	45, 40, 9, 12	57,872	51,140	51,797
Port of South Louisiana	91	45	246,509	78,410	2,528
Port of Plaquemines, LA	138	45	54,093	71,245	604
Passes of the Mississippi River, LA	60.18	13, 45	227,981	3,264	5596
Mississippi River Gulf Outlet via Venice Vicinity Consolidation	22	16, 14, 14	1,881	38	7,408
Petit Anse, Tigre, and Carlin Bayous	28	6, 9, 5, 7	2,724	0	2,943
Port of Iberia	14	13	2,200	NA	NA
Port of Morgan City, LA	-	12	1,558	212	10,363
Waterway from Empire, LA to the Gulf of Mexico	17	6, 9, 14	865	0	7,374
Waterway from Intracoastal Waterway to Bayou Dulac, LA	61	14	75	0	893
Texas Harbors, Channels, and Waterways					
Brazos Island Harbor, TX	50	36.5, 31, 38, 12, 14, 7	5,907	236	1,273
Cedar Bayou, TX	23	11	1,177	0	1,075
Channel to Aransas Pass, TX	12	14	945	3	1,075
Channel to Port Bolivar, TX	17	12		0	18,111
Corpus Christi Ship Channel, TX	58	47, 45, 46, 47, 14, 9	70,538	1,415	99,280
Dickenson Bayou, TX	34	9	150	0	92
Freeport Harbor, TX	15	44, 37, 18, 40	23,312	866	2,966
Galveston Channel, TX	7	41	13,744	2,703	22,419
Houston Ship Channel, TX	119	45, 40, 32-39, 9, 7, 35-37, 7, 40, 12	237,799	6,029	79,118
Matagorda Ship Channel, TX	91	35, 9.8, 10, 12.8, 2	9,333	329	1,847
Sabine-Neches Waterway, TX	160	40, 37, 39, 32, 27, 20, 9, 8	137,218	1,908	31,828
Texas City Channel, TX	14	43, 41, 42, 42	57,758	776	6,625

Source: U.S. Dept. of the Army, COE, 2011.

Table 3-8

Number and Volume of Chemical and Synthetic-Based Fluid Spills
in the Gulf of Mexico during 2005-2012

Spill Size (bbl)	2005		2006		2007		2008	
	Chemical	SBF	Chemical	SBF	Chemical	SBF	Chemical	SBF
50-<100	3	0	1	1	0	0	5	0
100-<500	2	5	1	4	0	1	4	1
500-<1,000	1	0	0	0	1	0	3	0
≥1,000	0	0	0	0	0	1	0	1
Spill Size (bbl)	2009		2010		2011		2012	
	Chemical	SBF	Chemical	SBF	Chemical	SBF	Chemical	SBF
50-<100	1	1	0	2	0	1	1	2
100-<500	2	3	1	0	0	1	2	1
500-<1,000	0	0	0	0	0	0	1	0
≥1,000	0	0	0	0	0	0	0	0

Notes: SBF = synthetic-based fluid.
The SBF fraction of the whole drilling fluid was recorded, not the total volume of drilling fluid.

Source: USDOI, BSEE, 2013.

Table 3-9

Quantities of Dredged Materials Disposed of
in Ocean Dredged-Material Disposal Sites between 2001 and 2010

Galveston District		
Year	Amount Disposed of in ODMDS	
	yd^3	m^3
2001	6,828,807	5,221,000
2002	4,874,468	3,726,800
2003	8,221,774	6,286,000
2004	4,079,104	3,118,700
2005	1,250,923	956,400
2006	9,182,594	7,020,600
2007	6,361,607	4,863,800
2008	5,665,124	4,331,300
2009	16,295,749	12,459,000
2010	6,226,627	4,760,600
Average	6,898,678	5,274,420
New Orleans District		
Year	Amount Disposed of in ODMDS	
	yd^3	m^3
2001	23,273,662	17,794,000
2002	57,646,327	44,073,800
2003	22,547,619	17,238,900
2004	21,157,530	16,176,100
2005	21,404,471	16,364,900
2006	13,494,251	10,317,100
2007	17,551,773	13,419,300
2008	16,801,795	12,845,900
2009	7,619,332	5,825,400
2010	15,386,985	11,764,200
Average	21,688,375	16,581,960

ODMDS = ocean dredged-material disposal sites.

Sources: U.S. Dept. of the Army, COE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010a, and 2010b.

Table 3-10

Number of Vessel Calls at U.S. Gulf Ports Between 2002 and 2011[1]

Vessel Type	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Tanker-Product[2,3]	5,100	5,143	5,764	6,171	6,594	6,784	6,597	6,451	7,000	8,413
Tanker - Crude[2,4]	3,698	4,227	4,361	4,303	4,343	4,614	4,574	4,502	5,150	5,626
Container [5]	1,262	1,263	1,284	1,378	1,354	1,306	1,372	1,641	1,934	2,338
Dry Bulk[6]	4,983	4,837	4,959	4,575	5,289	4,988	4,563	4,021	3,475	3,917
RO-RO (Roll-on Roll-off)[7]	431	398	370	337	423	386	374	491	549	566
Gas[8]	514	624	548	558	622	628	462	441	500	604
Combo[9]	418	375	258	201	155	135	116	102	94	66
General[10]	1,267	1,167	1,141	1,160	1,246	1,362	1,363	1,300	1,387	1,459
All Types	17,673	18,034	18,685	18,683	20,026	20,203	19,421	18,949	20,089	22,989

[1] The data in this report are only for oceangoing self-propelled vessels of 10,000 deadweight (DWT) capacity or greater. In 2005, these vessels accounted for 98% of the capacity calling at U.S. ports.
[2] Petroleum tankers and chemical tankers.
[3] 10,000-69,999 DWT.
[4] >70,000 DWT.
[5] Container carriers, refrigerated container carriers.
[6] Bulk vessels, bulk containerships, cement carriers, ore carriers, wood-chip carriers.
[7] RO/RO vessels, RO/RO containerships, vehicle carriers.
[8] Liquefied natural gas carriers, liquefied natural gas/liquefied petroleum gas carriers, liquefied petroleum carriers.
[9] Ore/bulk/oil carriers, bulk/oil carriers.
[10] General cargo carriers, partial containerships, refrigerated ships, barge carriers, livestock carriers.

Source: USDOT, MARAD, 2013.

Table 3-11

Corps of Engineers' Galveston District Maintenance Dredging Activity
for Federal Navigation Channels in Texas, 2001-2010*

Harbor, Channel, or Waterway	Year	Volume Dredged	
		yd^3	m^3
Sabine-Neches Waterway	2001	4,063,801	3,107,000
Freeport Harbor and Channel	2001	2,478,565	1,895,000
Matagorda Ship Channel	2001	285,656	218,400
Freeport Harbor and Channel	2002	1,996,455	1,526,400
Sabine-Neches Waterway	2002	2,878,013	2,200,400
Corpus Christi Ship Channel	2003	930,737	711,600
Sabine-Neches Waterway	2003	3,545,198	2,710,500
Freeport Harbor	2003	1,650,110	1,261,600
Galveston Harbor and Channel	2003	2,095,728	1,602,300
Freeport Harbor	2004	1,854,150	1,417,600
Matagorda Ship Channel	2004	365,180	279,200
Sabine-Neches Waterway	2004	1,859,774	1,421,900
Sabine-Neches Waterway	2005	1,062,709	812,500
Freeport Harbor	2005	188,214	143,900
Sabine-Neches Waterway	2006	1,523,762	1,165,000
Freeport Harbor	2006	3,427,221	2,620,300
Galveston Harbor and Channel	2006	3,744,661	2,863,000
Matagorda Ship Channel	2006	336,666	257,400
Corpus Christi Ship Channel	2006	149,760	114,500
Freeport Harbor	2007	2,427,817	1,856,200
Galveston Harbor	2007	2,939,094	2,247,100
Corpus Christi Ship Channel	2007	954,673	729,900
Sabine-Neches Waterway	2007	40,023	30,600
Sabine-Neches Waterway	2008	1,691,964	1,293,600
Freeport Harbor	2008	1,577,257	1,205,900
Galveston Harbor and Channel	2008	2,422,062	1,851,800
Freeport Harbor	2009	2,420,885	1,850,900
Corpus Christi Ship Channel	2009	118,108	90,300
Sabine-Neches Waterway	2009	5,811,876	4,443,500
Houston Ship Channel	2009	883,520	675,500
Galveston Harbor and Channel	2009	7,061,360	5,398,800
Corpus Christi Ship Channel	2010	791,964	605,500
Sabine-Neches Waterway	2010	2,669,395	2,040,900
Houston Ship Channel	2010	261,067	199,600
Galveston Harbor and Channel	2010	2,066,823	1,580,200
Freeport Harbor	2010	429,923	328,700
Total		69,004,172	52,757,500

* Dredged material disposed of in Ocean Dredged-Material Disposal Site.

Sources: U.S. Dept. of the Army, COE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010a, and 2010b.

Table 3-12

Corps of Engineers' New Orleans District Maintenance Dredging Activity
for Federal Navigation Channels in Louisiana, 2001-2010*

Harbor, Channel, or Waterway	Year	Volume Dredged	
		yd^3	m^3
Atchafalaya River Bar Channel, St. Mary Parish - Atchafalaya River and Bayous Chene, Boeuf, and Black, LA	2001	14,371,885	10,988,100
Calcasieu River Bar Channel, Cameron Parish	2001	240,532	183,900
Mississippi River Gulf Outlet Bar Channel	2001	1,449,732	1,108,400
Mississippi River, Baton Rouge to Southwest Pass	2001	7,211,513	5,513,600
Atchafalaya River Bar Channel, St. Mary Parish - Atchafalaya River and Bayous Chene, Boeuf, and Black, LA	2002	29,644,948	22,665,200
Mississippi River, Baton Rouge to Southwest Pass	2002	15,758,312	12,048,100
Mississippi River Gulf Outlet Bar Channel	2002	2,907,311	2,222,800
Calcasieu River Bar Channel, Cameron Parish	2002	9,335,755	7,137,700
Mississippi River Gulf Outlet	2003	2,265,369	1,732,000
Calcasieu River and Pass Bar Channel, Cameron Parish	2003	1,703,736	1,302,600
Atchafalaya River Bar Channel, St. Mary Parish - Atchafalaya River and Bayous Chene, Boeuf, and Black, LA	2003	11,700,921	8,946,000
Mississippi River Southwest Pass	2003	6,877,593	5,258,300
Mississippi River Gulf Outlet	2004	3,810,582	2,913,400
Atchafalaya River Bar Channel	2004	10,818,708	8,271,500
Calcasieu River and Pass Bar Channel, Cameron Parish	2004	688,766	526,600
Mississippi River Southwest Pass	2004	5,839,474	4,464,600
Mississippi River Gulf Outlet Bar Channel	2005	909,156	695,100
Atchafalaya River Bar Channel	2005	12,811,239	9,794,900
Calcasieu River and Pass Bar Channel	2005	1,683,724	1,287,300
Mississippi River Southwest Pass	2005	6,000,351	4,587,600
Atchafalaya River Bar Channel	2006	8,169,063	6,245,700
Calcasieu River and Pass Bar Channel	2006	1,740,358	1,330,600
Mississippi River Southwest Pass	2006	3,584,829	2,740,800
Mississippi River Southwest Pass	2007	3,004,492	2,297,100
Calcasieu River and Pass Bar Channel	2007	241,840	184,900
Atchafalaya River Bar Channel	2007	14,305,442	10,937,300
Atchafalaya River Bar Channel	2008	9,546,335	7,298,700
Calcasieu River and Pass Bar Channel	2008	364,656	278,800
Mississippi River Southwest Pass	2008	6,890,804	5,268,400
Atchafalaya River Bar Channel	2009	672,417	514,100
Calcasieu River and Pass Bar Channel	2009	1,149,426	878,800
Mississippi River Southwest Pass	2009	5,797,488	4,432,500
Calcasieu River and Pass Bar Channel	2010	829,502	634,200
Mississippi River Southwest Pass	2010	6,070,588	4,641,300
Total		208,396,847	159,330,900

* Dredged material disposed in Ocean Dredged-Material Disposal Site.

Sources: U.S. Dept. of the Army, COE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010a, and 2010b.

Table 3-13

Corps of Engineers' Mobile District Maintenance Dredging Activity
for Federal Navigation Channels in Mississippi, Alabama, and Florida, 2000-2010*

Harbor, Channel, or Waterway	Year	Volume Dredged	
		yd^3	m^3
Mobile Harbor	2001	4,594,174	3,512,500
Pascagoula Harbor	2001	3,200,030	2,446,600
Pascagoula Harbor and Bayou Casotte Extension	2001	294,812	225,400
Mobile Harbor	2002	4,101,600	3,135,900
Gulfport Harbor	2002	943,032	721,000
Pascagoula Harbor	2002	630,301	481,900
Mobile River	2003	2,067,607	1,580,800
Mobile Harbor	2003	1,723,355	1,317,600
Mobile Bay Channel	2003	2,741,725	2,096,200
Mobile Bay	2003	253,350	193,700
Gulfport Bar	2003	128,310	98,100
Pascagoula Bar	2003	123,340	94,300
Pascagoula Navy Channel	2003	558,756	427,200
Gulfport Harbor	2003	542,799	415,000
Bayou Casotte	2003	294,681	225,300
Pascagoula Sound	2003	120,855	92,400
Mobile Harbor	2004	7,849,270	6,001,200
Pascagoula Harbor	2004	1,203,576	920,200
Gulfport Harbor	2004	849,514	649,500
Mobile Harbor	2005	3,224,097	2,465,000
Pensacola Harbor	2005	63,043	48,200
Pascagoula Bar	2005	120,070	91,800
Gulfport Bar	2005	390,031	298,200
Mobile Harbor	2006	2,546,709	1,947,100
Pascagoula Harbor	2006	672,548	514,200
Mobile Harbor	2007	1,952,900	1,493,100
Mobile Harbor Federal Navigation Project	2008	3,725,303	2,848,200
Mobile Harbor	2009	5,980,209	4,572,200
Pascagoula Harbor	2009	152,769	116,800
Gulfport Harbor	2009	4,218,924	3,225,600
Mobile Harbor	2010	4,362,013	3,335,000
Gulfport Harbor	2010	8,486,895	6,488,700
Total		68,116,598	52,078,900

* Dredged material disposed in Ocean Dredged-Material Disposal Site.

Sources: U.S. Dept. of the Army, COE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010a, and 2010b.

Table 4-1

Unusual Mortality Event Cetacean Data for the Northern Gulf of Mexico

Cetaceans Stranded	Phase of Oil-Spill Response	Dates
114 cetaceans stranded	Prior to the response phase for the oil spill	February 1, 2010-April 29, 2010
122 cetaceans stranded or were reported dead offshore	During the initial response phase to the oil spill	April 30, 2010-November 2, 2010
850 cetaceans stranded*	After the initial response phase ended	November 3, 2010-November 24, 2013**

Note: Numbers are preliminary and may be subject to change. As of February 2, 2014, the unusual mortality event involves 1,086 cetacean "strandings" in the northern Gulf of Mexico (USDOC, NMFS, 2014).

* This number includes six dolphins that were killed incidental to fish-related scientific data collection and one dolphin that was killed incidental to trawl relocation for a dredging project.

** The initial response phase ended for all four states on November 3, 2010, but then reopened for eastern and central Louisiana on December 3, 2010, and closed again on May 25, 2011.

Table 4-2

Economic Significance of Commercial Fishing 2011

State	Landings Revenue (thousand $)[1]	Sales Impacts (thousand $)[1]	Job Impacts[1]	CFLQ[2]
Alabama	50,941	499,805	11,011	0.87
Louisiana	333,619	1,801,568	32,818	1.58
Mississippi	30,300	247,106	5,550	ND
Texas	239,082	2,277,959	27,717	0.20
West Florida	164,076	14,250,006	72,341	1.00
Total	818,018	19,076,444	149,437	–

Notes: CFLQ = commercial fishing quotient.
ND = These data are confidential, thus not disclosable.
[1] Landings Revenue, Sales Impacts, and Job Impacts are based on 2011 data.
[2] The CFLQ data are based on 2010 data.

Source: USDOC, NMFS, 2013a.

Table 4-3

Angler Trips in the Gulf of Mexico by Location and Mode from 2008 through 2012

State	Area	2008	2009	2010	2011	2012	% State Total in 2012
Alabama	Shore Ocean (< 3 nmi)	249,893	322,126	447,041	603,546	750,159	32.54%
	Shore Inland	452,192	449,470	365,234	598,700	461,221	20.01%
	Charter Ocean (<3 nmi)	9,967	9,166	8,860	19,874	15,785	0.68%
	Charter Ocean (>3 nmi)	38,046	36,259	17,424	48,616	28,340	1.23%
	Charter Inland	7,700	10,656	7,221	6,351	14,536	0.63%
	Private/Rental Ocean (<3 nmi)	247,876	131,997	114,816	191,563	137,321	5.96%
	Private/Rental Ocean (>3 nmi)	74,074	134,411	69,335	188,994	131,897	5.72%
	Private/Rental Inland	624,197	618,502	656,226	825,821	766,027	33.23%
	Total	1,703,945	1,712,587	1,686,157	2,483,465	2,305,286	
West Florida	Shore Ocean (< 9 nmi)	3,076,591	2,688,011	1,610,807	1,982,194	2,199,810	14.88%
	Shore Inland	3,704,990	3,793,756	4,034,208	3,862,665	4,016,544	27.18%
	Charter Ocean (<9 nmi)	187,810	196,753	159,317	179,880	242,666	1.64%
	Charter Ocean (>9 nmi)	255,300	262,005	203,201	236,088	307,121	2.08%
	Charter Inland	127,801	113,842	98,440	119,826	149,315	1.01%
	Private/Rental Ocean (<9 nmi)	3,624,073	2,605,196	2,257,349	1,901,217	2,087,991	14.13%
	Private/Rental Ocean (>9 nmi)	1,242,935	751,869	681,551	500,067	755,470	5.11%
	Private/Rental Inland	5,277,665	5,265,888	5,221,323	5,118,740	5,021,267	33.97%
	Total	17,497,165	15,677,320	14,266,196	13,900,677	14,780,184	
Louisiana	Shore Ocean (< 3 nmi)	62,712	38,930	11,664	48,893	152,094	3.68%
	Shore Inland	870,042	730,053	717,006	1,073,035	978,657	23.66%
	Charter Ocean (<3 nmi)	10,468	3,931	2,762	6,937	3,646	0.09%
	Charter Ocean (>3 nmi)	32,805	21,173	8,106	15,742	19,827	0.48%
	Charter Inland	135,915	157,692	68,018	90,057	91,192	2.20%
	Private/Rental Ocean (<3 nmi)	97,797	81,008	59,347	77,986	116,854	2.82%
	Private/Rental Ocean (>3 nmi)	89,859	99,352	11,568	80,952	88,503	2.14%
	Private/Rental Inland	3,320,459	2,995,875	2,984,016	3,182,645	2,685,791	64.93%
	Total	4,620,057	4,128,014	3,862,487	4,576,247	4,136,564	

Table 4-3. Angler Trips in the Gulf of Mexico by Location and Mode from 2008 through 2012 (continued)

State	Area	2008	2009	2010	2011	2012	% State Total in 2012
Mississippi	Shore Ocean (< 3 nmi)	0	143	0	0	811	0.04%
	Shore Inland	359,438	309,612	596,544	760,788	947,075	48.56%
	Charter Ocean (<3 nmi)	4,286	2,803	904	3,123	1,628	0.08%
	Charter Ocean (>3 nmi)	718	330	949	221	125	0.01%
	Charter Inland	8,229	7,656	4,989	7,891	9,738	0.50%
	Private/Rental Ocean (<3 nmi)	12,056	16,962	12,419	18,682	4,116	0.21%
	Private/Rental Ocean (>3 nmi)	28,007	26,316	4,626	12,974	41,137	2.11%
	Private/Rental Inland	555,951	715,505	612,162	811,711	945,819	48.49%
	Total	968,685	1,079,327	1,232,593	1,615,390	1,950,449	
Gulf Total	Shore Ocean (< 3 nmi)	3,389,196	3,049,210	2,069,512	2,634,633	3,102,874	13.39%
	Shore Inland	5,386,662	5,282,891	5,712,992	6,295,188	6,403,497	27.63%
	Charter Ocean (<3 nmi)	212,531	212,653	171,843	209,814	263,725	1.14%
	Charter Ocean (>3 nmi)	326,869	319,767	229,680	300,667	355,413	1.53%
	Charter Inland	279,645	289,846	178,668	224,125	264,781	1.14%
	Private/Rental Ocean (<3 nmi)	3,981,802	2,835,163	2,443,931	2,189,448	2,346,282	10.13%
	Private/Rental Ocean (>3 nmi)	1,434,875	1,011,948	767,080	782,987	1,017,007	4.39%
	Private/Rental Inland	9,778,272	9,595,770	9,473,727	9,938,917	9,418,904	40.65%
	Total	24,789,852	22,597,248	21,047,433	22,575,779	23,172,483	

Notes: This table presents the sum of fishing data from Louisiana, Mississippi, Alabama, and West Florida.
State waters in Florida extend 9 nmi from the coast rather than the typical 3 nmi.

Source: USDOC, NMFS, 2013b.

Table 4-4

Fish Species Caught by Recreational Anglers from 2008 through 2012

Species/Year	2008	2009	2010	2011	2012
Panel A: Number of Fish					
Atlantic Croaker	5,020,732	5,029,701	5,337,312	7,950,146	5,226,056
Black Drum	1,975,432	1,770,479	1,763,633	1,884,447	1,742,449
Blackfin Tuna	137,887	84,978	32,147	53,829	108,196
Cobia	160,155	86,106	62,400	109,388	94,150
Dolphins	640,488	401,891	270,119	456,829	368,565
Gag	4,556,734	2,969,559	2,260,741	1,269,038	1,125,765
Gray Snapper	7,316,720	4,446,255	2,451,867	2,800,767	4,525,563
Great Amberjack	248,910	212,229	382,672	250,954	167,585
King mackerel	374,338	673,530	291,065	244,812	367,142
Little Tuny	203,560	168,356	140,474	201,761	336,497
Pinfishes	16,112,529	9,876,807	10,415,589	8,851,759	13,360,140
Red Drum	10,310,311	8,132,874	9,718,538	9,992,160	9,018,589
Red Grouper	3,105,159	3,172,238	2,242,746	2,009,532	2,010,089
Red Snapper	2,789,675	2,941,448	1,769,536	2,041,512	2,015,848
Sand Seatrout	5,335,003	6,632,448	6,329,040	8,268,113	7,352,122
Sheepshead	3,055,781	2,911,901	2,884,114	3,849,215	2,968,888
Southern Flounder	594,926	837,108	991,760	987,796	1,050,315
Southern Kingfish	1,590,202	1,417,523	1,450,408	1,163,302	835,582
Spanish Mackerel	3,938,013	3,138,754	4,040,757	3,475,966	3,278,437
Spotted Seatrout	35,141,138	30,700,217	24,703,470	32,700,839	32,997,778
Striped Mullet	1,405,717	967,398	1,791,862	2,214,375	2,559,404
White Grunt	3,721,050	2,285,007	2,494,075	2,852,807	3,405,536
Panel B: Pounds					
Atlantic Croaker	746,737	417,298	529,427	816,562	608,874
Black Drum	3,329,225	2,720,006	2,433,846	2,487,203	3,195,532
Blackfin Tuna	854,254	1,225,530	276,947	415,204	1,450,081
Cobia	797,585	510,151	483,465	1,132,455	876,210
Dolphins	1,758,506	2,114,876	685,194	1,295,453	1,435,715
Gag	3,250,623	1,485,256	1,630,999	665,580	1,018,029
Gray Snapper	2,016,456	1,525,684	882,715	1,250,520	1,506,738
Great Amberjack	1,407,076	1,523,734	1,483,609	946,467	1,326,805
King Mackerel	1,804,192	3,677,465	1,808,493	1,679,476	2,501,381
Little Tuny	439,608	517,938	418,973	455,612	1,195,713
Pinfishes	2,029,509	801,445	2,028,069	1,574,080	1,172,020
Red Drum	14,496,283	11,773,528	13,509,248	15,340,878	11,964,241
Red Grouper	879,028	981,966	762,208	640,002	1,784,678
Red Snapper	2,806,925	3,648,516	1,655,857	3,486,486	4,446,272

Table 4-4. Fish Species Caught by Recreational Anglers from 2008 through 2012 (continued)

Species/Year	2008	2009	2010	2011	2012
Panel B: Pounds					
Sand Seatrout	1,880,159	2,308,490	2,579,227	3,412,201	2,545,250
Sheepshead	4,415,722	3,904,616	3,296,696	6,990,784	3,816,260
Southern Flounder	687,368	910,196	1,104,725	1,120,655	1,039,927
Southern Kingfish	553,205	638,419	568,799	390,627	292,906
Spanish Mackerel	2,943,974	2,072,995	2,546,029	2,132,604	2,677,171
Spotted Seatrout	16,156,781	15,393,934	12,259,023	17,924,543	16,211,441
Striped Mullet	1,614,209	899,038	2,674,277	2,055,630	1,981,230
White Grunt	1,131,685	1,030,272	930,723	1,266,126	1,407,171

Source: USDOC, NMFS, 2013c.

Table 4-5

Economic Impact of Recreational Fishing in the Gulf of Mexico in 2011

	Expenditures	Sales	Value Added	Employment
Alabama	856,334	797,280	410,222	8,177
West Florida	5,494,694	4,881,831	2,653,677	47,047
Mississippi	149,129	145,769	60,735	1,181
Louisiana	1,879,471	1,602,913	806,349	17,764
Texas	1,402,516	1,853,361	952,284	15,150
Total	9,782,144	9,281,154	4,883,267	89,319

Note: Expenditures, Sales, and Value Added are presented in thousands of dollars.

Source: USDOC, NMFS, 2013a.

Table 4-6

Employment in the Leisure/Hospitality Industry in Selected Geographic Regions

Region	2008	2009	2010	2011	2012
Panel A: EIA					
TX-1	54,551	53,772	54,750	56,753	60,670
TX-2	16,883	16,718	16,934	18,197	19,915
TX-3	240,231	240,425	244,821	253,071	267,390
LA-1	14,295	14,214	13,979	14,489	14,635
LA-2	21,364	20,675	20,618	21,345	22,137
LA-3	46,037	44,414	44,796	47,121	48,930
LA-4	68,605	68,161	72,757	76,552	78,978
MS-1	27,702	26,904	26,981	27,826	28,409
AL-1	26,516	25,872	26,925	27,300	28,307
FL-1	40,001	41,002	42,550	45,160	46,720
FL-2	22,502	21,689	22,111	22,466	23,579
FL-3	146,368	142,302	145,324	148,103	158,030
FL-4	283,359	279,839	289,247	304,093	319,912
TX EIA total	311,665	310,915	316,505	328,021	347,975
LA EIA total	150,301	147,464	152,150	159,507	164,680
MS EIA total	27,702	26,904	26,981	27,826	28,409
AL EIA total	26,516	25,872	26,925	27,300	28,307
FL EIA total	492,230	484,832	499,232	519,822	548,241
EIA total	1,008,414	995,987	1,021,793	1,062,476	1,117,612
Panel B: Coastal					
TX	67,087	67,818	68,260	71,041	75,895
LA	45,545	45,418	49,432	51,742	53,802
MS	25,575	25,055	25,186	25,900	26,353
AL	24,319	23,825	24,816	25,145	25,941
FL	386,892	383,959	396,485	415,379	437,509
Coastal total	549,418	546,075	564,179	589,207	619,500
Panel C: Statewide					
TX	995,445	982,840	1,006,277	1,039,839	1,094,916
LA	194,905	190,589	194,387	202,704	208,284
MS	121,033	115,868	116,204	117,874	120,472
AL	168,413	165,953	165,230	166,671	170,854
FL	922,534	896,383	929,448	962,616	1,011,874
State total	2,402,330	2,351,633	2,411,546	2,489,704	2,606,400

(1) Economic Impact Areas are defined in Figure 4-20 of the 2012-2017 WPA/CPA Multisale EIS.
(2) The Coastal category refers to counties within EIA's that are directly along the coast of the U.S.
(3) The Statewide category refers to the number of employees within the borders of the entire state.
(4) The leisure/hospitality industry is defined according to the North American Industrial Classification System (NAICS).
(5) The employment figure for any given year corresponds to the total number of employees in December of that year.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2013.

Table 4-7

Peak Population Projected from Cumulative OCS Programs as a Percent of Total Population

EIA	Low Case				High Case			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	16,250	2030	2,453,620	0.66%	25,369	2031	2,485,990	1.02%
TX-2	6,620	2031	854,250	0.77%	10,759	2031	854,250	1.26%
TX-3	137,573	2030	8,927,830	1.54%	203,022	2031	9,061,710	2.24%
Louisiana (LA)								
LA-1	8,959	2030	410,370	2.18%	14,763	2031	413,690	3.57%
LA-2	25,960	2030	792,830	3.27%	40,748	2031	803,500	5.07%
LA-3	33,867	2030	1,375,330	2.46%	54,048	2031	1,387,050	3.90%
LA-4	17,490	2030	1,389,220	1.26%	27,980	2031	1,396,050	2.00%
Florida (FL)								
FL-1	4,773	2031	1,119,900	0.43%	7,726	2031	1,119,900	0.69%
FL-2	9,402	2031	835,070	1.13%	15,307	2031	835,070	1.83%
FL-3	8,265	2031	4,857,480	0.17%	13,509	2031	4,857,480	0.28%
FL-4	5,916	2031	8,090,210	0.07%	9,658	2031	8,090,210	0.12%
Alabama (AL)								
AL-1	11,251	2030	848,420	1.33%	18,405	2031	854,710	2.15%
Mississippi (MS)								
MS-1	8,726	2030	546,670	1.60%	14,116	2031	549,830	2.57%

Sources: Peak employment output from BOEM's economic impact model (MAG-PLAN)
Baseline employment projections based on Woods & Poole Economics, Inc. (2013).

Table 4-8

Baseline Population Projections (in thousands) by Economic Impact Area

Model Year	Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4	Total
	2010	1,799.29	626.91	6,202.21	346.02	585.06	1,142.41	1,242.69	482.30	725.87	882.80	659.96	3,626.40	6,170.12	24,492.03
	2011	1,827.28	633.41	6,309.03	346.51	588.41	1,147.53	1,260.01	486.36	727.78	889.79	661.80	3,663.94	6,273.04	24,814.88
	2012	1,858.83	644.11	6,442.79	349.64	598.63	1,158.87	1,265.95	489.21	733.64	900.72	670.02	3,721.36	6,360.03	25,193.79
	2013	1,890.78	654.92	6,577.78	352.85	608.98	1,170.43	1,272.16	492.17	739.67	911.84	678.38	3,779.50	6,448.27	25,577.71
	2014	1,923.07	665.83	6,713.83	356.11	619.45	1,182.18	1,278.59	495.21	745.81	923.11	686.86	3,838.27	6,537.57	25,965.90
	2015	1,955.52	676.78	6,850.35	359.40	629.98	1,194.01	1,285.13	498.29	752.02	934.45	695.39	3,897.31	6,627.34	26,355.96
	2016	1,988.13	687.77	6,987.28	362.72	640.58	1,205.90	1,291.75	501.40	758.28	945.85	703.97	3,956.58	6,717.51	26,747.72
	2017	2,020.90	698.81	7,124.69	366.07	651.23	1,217.87	1,298.48	504.55	764.59	957.31	712.59	4,016.12	6,808.15	27,141.35
	2018	2,053.85	709.89	7,262.62	369.43	661.96	1,229.92	1,305.31	507.74	770.96	968.84	721.28	4,075.96	6,899.27	27,537.02
	2019	2,086.93	721.00	7,400.96	372.82	672.73	1,242.03	1,312.22	510.96	777.37	980.44	730.00	4,136.02	6,990.77	27,934.25
	2020	2,120.07	732.12	7,539.40	376.22	683.54	1,254.14	1,319.15	514.19	783.79	992.04	738.73	4,196.13	7,082.36	28,331.89
	2021	2,152.43	742.96	7,673.56	379.58	694.11	1,266.08	1,326.11	517.41	790.17	1,003.45	747.33	4,254.87	7,172.13	28,720.19
	2022	2,185.28	753.96	7,810.10	382.98	704.85	1,278.14	1,333.11	520.65	796.60	1,015.00	756.02	4,314.43	7,263.04	29,114.14
	2023	2,218.63	765.12	7,949.07	386.40	715.75	1,290.31	1,340.14	523.91	803.08	1,026.67	764.81	4,374.83	7,355.10	29,513.82
	2024	2,252.49	776.44	8,090.52	389.85	726.83	1,302.60	1,347.21	527.19	809.61	1,038.48	773.71	4,436.07	7,448.33	29,919.33
	2025	2,286.87	787.94	8,234.48	393.34	738.07	1,315.00	1,354.31	530.49	816.20	1,050.43	782.71	4,498.17	7,542.74	30,330.75
	2026	2,319.29	798.75	8,368.70	396.69	748.71	1,326.85	1,361.22	533.69	822.55	1,061.81	791.29	4,556.81	7,632.28	30,718.63
	2027	2,352.16	809.70	8,505.11	400.06	759.50	1,338.81	1,368.17	536.91	828.94	1,073.32	799.96	4,616.21	7,722.88	31,111.75
	2028	2,385.51	820.81	8,643.74	403.47	770.45	1,350.88	1,375.15	540.14	835.38	1,084.95	808.72	4,676.39	7,814.56	31,510.17
	2029	2,419.33	832.08	8,784.64	406.90	781.56	1,363.05	1,382.17	543.40	841.88	1,096.70	817.59	4,737.36	7,907.32	31,913.98
	2030	2,453.62	843.49	8,927.83	410.37	792.83	1,375.33	1,389.22	546.67	848.42	1,108.59	826.55	4,799.12	8,001.19	32,323.24
	2031	2,485.99	854.25	9,061.71	413.69	803.50	1,387.05	1,396.05	549.83	854.71	1,119.90	835.07	4,857.48	8,090.21	32,709.43
	2032	2,518.78	865.14	9,197.61	417.03	814.31	1,398.87	1,402.90	553.01	861.04	1,131.33	843.69	4,916.55	8,180.22	33,100.46
	2033	2,552.00	876.17	9,335.54	420.41	825.27	1,410.78	1,409.79	556.20	867.42	1,142.87	852.40	4,976.33	8,271.23	33,496.40
	2034	2,585.67	887.34	9,475.53	423.81	836.37	1,422.80	1,416.71	559.41	873.84	1,154.53	861.20	5,036.85	8,363.25	33,897.31
	2035	2,619.77	898.65	9,617.63	427.24	847.63	1,434.92	1,423.67	562.64	880.32	1,166.31	870.08	5,098.10	8,456.30	34,303.26
	2036	2,652.33	909.44	9,752.11	430.57	858.40	1,446.66	1,430.55	565.82	886.64	1,177.68	878.66	5,156.70	8,545.68	34,691.24
	2037	2,685.30	920.36	9,888.47	433.94	869.31	1,458.50	1,437.47	569.02	893.01	1,189.15	887.32	5,215.97	8,636.01	35,083.82
	2038	2,718.67	931.41	10,026.73	437.32	880.36	1,470.43	1,444.43	572.23	899.42	1,200.74	896.06	5,275.93	8,727.29	35,481.03

Table 4-8. Baseline Population Projections (in thousands) by Economic Impact Area (continued)

Model Year	Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4	Total
	2039	2,752.46	942.59	10,166.93	440.74	891.55	1,482.46	1,451.41	575.46	905.88	1,212.44	904.89	5,336.57	8,819.54	35,882.93
	2040	2,786.67	953.91	10,309.09	444.18	902.89	1,494.59	1,458.44	578.72	912.38	1,224.25	913.81	5,397.92	8,912.76	36,289.59
	2041	2,821.31	965.36	10,453.24	447.65	914.36	1,506.82	1,465.49	581.99	918.93	1,236.18	922.81	5,459.96	9,006.96	36,701.06
	2042	2,856.37	976.95	10,599.40	451.15	925.99	1,519.14	1,472.58	585.27	925.53	1,248.23	931.90	5,522.72	9,102.17	37,117.41
	2043	2,891.87	988.68	10,747.60	454.67	937.76	1,531.57	1,479.70	588.58	932.18	1,260.39	941.09	5,586.20	9,198.37	37,538.68
	2044	2,927.82	1,000.55	10,897.88	458.22	949.68	1,544.10	1,486.86	591.91	938.87	1,272.67	950.36	5,650.41	9,295.60	37,964.94
	2045	2,964.20	1,012.57	11,050.26	461.80	961.75	1,556.73	1,494.05	595.25	945.61	1,285.07	959.73	5,715.36	9,393.85	38,396.25
	2046	3,001.05	1,024.72	11,204.77	465.41	973.98	1,569.47	1,501.28	598.61	952.40	1,297.59	969.18	5,781.06	9,493.14	38,832.67
	2047	3,038.35	1,037.03	11,361.44	469.05	986.36	1,582.31	1,508.54	602.00	959.24	1,310.24	978.73	5,847.51	9,593.49	39,274.27
	2048	3,076.11	1,049.48	11,520.30	472.71	998.90	1,595.26	1,515.84	605.40	966.13	1,323.00	988.38	5,914.72	9,694.89	39,721.11
	2049	3,114.34	1,062.08	11,681.38	476.40	1,011.59	1,608.31	1,523.17	608.82	973.07	1,335.89	998.12	5,982.71	9,797.36	40,173.24
	2050	3,153.05	1,074.83	11,844.72	480.12	1,024.45	1,621.46	1,530.54	612.26	980.06	1,348.91	1,007.95	6,051.48	9,900.92	40,630.75
	2051	3,192.24	1,087.73	12,010.34	483.87	1,037.47	1,634.73	1,537.94	615.72	987.09	1,362.05	1,017.89	6,121.04	10,005.57	41,093.69
	2052	3,231.91	1,100.79	12,178.27	487.65	1,050.66	1,648.10	1,545.38	619.19	994.18	1,375.33	1,027.92	6,191.40	10,111.33	41,562.12
	2053	3,272.08	1,114.01	12,348.55	491.46	1,064.02	1,661.59	1,552.86	622.69	1,001.32	1,388.73	1,038.05	6,262.57	10,218.20	42,036.12
	2054	3,312.75	1,127.39	12,521.21	495.30	1,077.54	1,675.18	1,560.37	626.21	1,008.51	1,402.26	1,048.28	6,334.55	10,326.21	42,515.76
	2055	3,353.92	1,140.92	12,696.29	499.17	1,091.24	1,688.89	1,567.92	629.75	1,015.75	1,415.92	1,058.61	6,407.36	10,435.35	43,001.10
2012/2051 Growth		1.40%	1.35%	1.61%	0.84%	1.42%	0.89%	0.50%	0.59%	0.76%	1.07%	1.08%	1.28%	1.17%	1.26%

Notes: Actual Woods & Poole data for 2010 through 2020, 2025, 2030, 2035, and 2040.
Missing estimates through 2040 calculated using average annual growth rate for the 5-year period; projections after 2040 calculated using the average annual growth rate from 2035 to 2040.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-9

Demographic and Employment Baseline Projections for Economic Impact Area AL-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	692.65	725.87	727.78	733.64	739.67	745.81	752.02	777.37	816.20	848.42	912.38
Age Under 19 Years	28.1%	27.1%	26.7%	26.6%	26.5%	26.4%	26.3%	26.2%	25.9%	25.5%	24.6%
Age 20 to 34	18.7%	18.6%	18.8%	18.8%	18.7%	18.6%	18.4%	17.6%	16.7%	16.5%	17.0%
Age 35 to 49	21.3%	19.7%	19.3%	19.0%	18.8%	18.6%	18.5%	18.5%	18.6%	18.5%	17.4%
Age 50 to 64	18.3%	20.1%	20.4%	20.5%	20.6%	20.6%	20.6%	20.1%	18.6%	17.8%	18.5%
Age 65 and over	13.5%	14.4%	14.7%	15.1%	15.5%	15.8%	16.2%	17.6%	20.2%	21.8%	22.6%
Median Age of Population (years)	38.2	39.9	40.2	40.5	40.8	41.0	41.1	41.8	43.0	43.8	45.0
White Population (in thousands)	66.2%	65.2%	65.0%	65.0%	64.9%	64.8%	64.8%	64.4%	63.9%	63.3%	62.4%
Black Population (in thousands)	29.6%	29.6%	29.6%	29.6%	29.5%	29.5%	29.5%	29.4%	29.4%	29.3%	29.1%
Native American Population (in thousands)	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%
Asian and Pacific Islander Population (in thousands)	1.2%	1.4%	1.4%	1.5%	1.5%	1.5%	1.5%	1.6%	1.7%	1.9%	2.0%
Hispanic or Latino Population (in thousands)	1.9%	2.7%	2.8%	2.9%	3.0%	3.1%	3.1%	3.4%	3.9%	4.3%	5.3%
Male Population (in thousands)	48.3%	48.4%	48.4%	48.4%	48.4%	48.4%	48.4%	48.5%	48.5%	48.5%	48.4%
Total Employment (in thousands of jobs)	363.84	373.38	378.73	379.89	385.02	390.21	395.45	417.11	451.70	482.56	550.51
Farm Employment	1.4%	1.5%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.2%	1.1%	1.0%
Forestry, Fishing, Related Activities	1.0%	0.9%	0.9%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.8%
Mining	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Utilities	0.4%	0.4%	0.4%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Construction	8.5%	7.6%	7.2%	7.4%	7.3%	7.3%	7.2%	7.0%	6.8%	6.5%	6.0%
Manufacturing	8.7%	7.2%	7.4%	7.6%	7.5%	7.3%	7.1%	6.6%	5.8%	5.1%	4.0%
Wholesale Trade	3.5%	3.1%	2.9%	2.8%	2.8%	2.8%	2.7%	2.7%	2.5%	2.4%	2.2%
Retail Trade	12.4%	11.9%	11.9%	12.1%	12.0%	12.0%	11.9%	11.8%	11.5%	11.2%	10.6%
Transportation and Warehousing	3.7%	3.6%	3.6%	3.6%	3.5%	3.5%	3.5%	3.4%	3.3%	3.1%	2.9%
Information Employment	1.3%	0.9%	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%
Finance and Insurance	3.4%	4.0%	4.1%	3.9%	3.9%	3.9%	3.9%	3.8%	3.7%	3.7%	3.5%
Real Estate/Rental and Lease	4.4%	5.0%	5.0%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
Professional and Technical Services	4.4%	4.5%	4.5%	4.6%	4.6%	4.6%	4.6%	4.7%	4.9%	5.0%	5.2%
Management	0.2%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.6%
Administrative and Waste Services	6.4%	7.0%	7.3%	7.5%	7.6%	7.7%	7.8%	8.1%	8.5%	8.9%	9.7%
Educational Services	1.4%	1.8%	1.9%	2.0%	2.0%	2.1%	2.1%	2.2%	2.4%	2.6%	2.9%

Table 4-9. Demographic and Employment Baseline Projections for Economic Impact Area AL-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	8.5%	9.4%	9.4%	9.3%	9.4%	9.5%	9.7%	10.1%	10.8%	11.4%	12.5%
Arts, Entertainment, and Recreation	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%
Accommodation and Food Services	6.8%	7.3%	7.5%	7.8%	7.9%	7.9%	8.0%	8.3%	8.8%	9.2%	10.0%
Other Services, Except Public Administration	7.7%	8.0%	8.1%	8.0%	8.0%	8.1%	8.2%	8.5%	8.9%	9.2%	9.8%
Federal Civilian Government	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%	0.7%	0.6%
Federal Military	1.3%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
State and Local Government	12.0%	11.6%	11.3%	10.9%	10.9%	10.8%	10.8%	10.5%	10.2%	9.9%	9.2%
Total Earnings (in millions of 2005 dollars)	12,929.16	13,560.46	13,587.24	13,806.61	14,074.10	14,370.28	14,672.46	15,943.93	18,055.24	20,023.71	24,628.20
Farm	0.8%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Forestry, Fishing, Related Activities	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%
Mining	0.4%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%
Utilities	1.0%	1.0%	1.0%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	0.9%
Construction	8.9%	8.7%	8.3%	8.5%	8.5%	8.4%	8.3%	7.9%	7.3%	6.9%	6.0%
Manufacturing	13.6%	12.6%	13.3%	14.3%	14.3%	14.1%	14.0%	13.3%	12.4%	11.6%	10.0%
Wholesale Trade	5.1%	4.7%	4.4%	4.2%	4.2%	4.2%	4.2%	4.1%	4.0%	3.9%	3.7%
Retail Trade	8.9%	8.2%	8.2%	8.2%	8.2%	8.1%	8.0%	7.6%	7.1%	6.7%	5.9%
Transportation and Warehousing	4.8%	5.1%	5.2%	5.3%	5.2%	5.2%	5.1%	5.0%	4.7%	4.5%	4.0%
Information	1.6%	1.2%	1.2%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%
Finance and Insurance	4.9%	4.4%	4.3%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%	3.8%	3.7%
Real Estate/Rental and Lease	2.3%	1.8%	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
Professional and Technical Services	5.5%	5.8%	5.9%	6.0%	6.1%	6.1%	6.2%	6.5%	6.9%	7.2%	7.9%
Management	0.3%	0.5%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.9%	1.0%	1.4%
Administrative and Waste Services	3.7%	4.3%	4.5%	4.7%	4.8%	4.8%	4.9%	5.2%	5.6%	6.0%	6.8%
Educational Services	0.9%	1.0%	1.1%	1.2%	1.2%	1.2%	1.2%	1.3%	1.5%	1.6%	1.9%
Health Care and Social Assistance	9.8%	10.8%	10.5%	10.3%	10.4%	10.6%	10.7%	11.4%	12.3%	13.1%	14.8%
Arts, Entertainment, and Recreation	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Accommodation and Food Services	3.2%	3.5%	3.6%	3.7%	3.8%	3.8%	3.8%	4.0%	4.3%	4.5%	4.9%
Other Services, Except Public Administration	4.8%	5.0%	5.0%	5.0%	5.0%	5.1%	5.1%	5.3%	5.5%	5.7%	6.2%
Federal Civilian Government	2.2%	2.4%	2.4%	2.4%	2.3%	2.3%	2.3%	2.3%	2.2%	2.1%	2.0%
Federal Military	1.8%	1.8%	1.7%	1.6%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%
State and Local Government	13.8%	14.8%	14.3%	13.8%	13.8%	13.8%	13.8%	13.7%	13.6%	13.5%	13.2%
Total Personal Income per Capita (in 2005 dollars)	26,923	28,669	29,148	29,334	29,496	29,782	30,134	31,910	35,178	38,384	46,143
Woods & Poole Economics Wealth Index (U.S. = 100)	68.7	72.3	71.7	71.7	71.6	71.7	71.8	72.2	72.7	72.9	73.3
Persons per Household (in number of people)	2.5	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table 4-9. Demographic and Employment Baseline Projections for Economic Impact Area AL-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	68,478	73,643	74,608	74,670	74,691	75,003	75,510	79,057	87,161	95,764	116,991
Number of Households (in thousands)	272.33	282.58	284.33	288.21	292.10	296.14	300.12	313.77	329.42	340.07	359.86
Income <$10,000 (thousands of households, 2000$)	13.4%	11.9%	11.7%	11.5%	11.3%	11.1%	10.9%	9.9%	8.2%	7.0%	5.0%
Income $10,000 to $19,999	14.6%	13.1%	12.9%	12.7%	12.6%	12.4%	12.2%	11.1%	9.3%	8.0%	5.8%
Income $20,000 to $29,999	13.1%	11.9%	11.7%	11.5%	11.4%	11.2%	11.1%	10.2%	8.5%	7.4%	5.3%
Income $30,000 to $44,999	18.8%	18.4%	18.2%	18.1%	18.0%	17.8%	17.6%	16.4%	14.0%	12.1%	8.7%
Income $45,000 to $59,999	14.8%	16.4%	16.7%	16.9%	17.1%	17.3%	17.5%	18.7%	19.5%	18.5%	13.8%
Income $60,000 to $74,999	9.5%	10.6%	10.8%	11.0%	11.1%	11.3%	11.5%	12.6%	15.1%	17.4%	19.3%
Income $75,000 to $99,999	8.3%	9.3%	9.5%	9.6%	9.8%	9.9%	10.1%	11.1%	13.3%	15.5%	21.9%
Income $100,000 or more	7.5%	8.4%	8.6%	8.7%	8.8%	9.0%	9.1%	10.0%	12.1%	14.2%	20.2%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA

Source: Woods & Poole Economics, Inc., 2013.

Table 4-10

Demographic and Employment Baseline Projections for Economic Impact Area FL-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	861.80	882.80	889.79	900.72	911.84	923.11	934.45	980.44	1,050.43	1,108.59	1,224.25
Age Under 19 Years	26.1%	25.0%	24.5%	24.3%	24.2%	24.2%	24.1%	24.3%	24.5%	24.3%	23.6%
Age 20 to 34	20.1%	20.5%	20.9%	21.0%	21.1%	21.1%	21.0%	19.9%	18.1%	17.5%	18.7%
Age 35 to 49	22.3%	20.1%	19.5%	18.9%	18.4%	18.0%	17.7%	17.8%	19.0%	19.6%	17.3%
Age 50 to 64	18.2%	20.1%	20.6%	20.7%	20.8%	20.9%	21.0%	20.4%	18.2%	16.3%	17.9%
Age 65 and over	13.3%	14.3%	14.6%	15.0%	15.5%	15.8%	16.2%	17.5%	20.1%	22.2%	22.6%
Median Age of Population (years)	39.5	40.3	40.5	40.6	40.7	40.8	40.8	40.9	41.6	42.3	42.6
White Population (in thousands)	79.1%	77.2%	76.8%	76.6%	76.4%	76.2%	76.0%	75.2%	73.9%	72.7%	70.3%
Black Population (in thousands)	13.5%	14.0%	14.2%	14.2%	14.2%	14.3%	14.3%	14.4%	14.6%	14.8%	15.0%
Native American Population (in thousands)	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.6%	0.5%
Asian and Pacific Islander Population (in thousands)	2.5%	2.8%	2.8%	2.9%	2.9%	2.9%	2.9%	3.0%	3.1%	3.2%	3.3%
Hispanic or Latino Population (in thousands)	4.0%	5.1%	5.4%	5.5%	5.7%	5.9%	6.0%	6.6%	7.7%	8.6%	10.8%
Male Population (in thousands)	50.1%	50.2%	50.2%	50.2%	50.3%	50.3%	50.3%	50.4%	50.7%	50.8%	51.1%
Total Employment (in thousands of jobs)	487.45	473.21	483.35	489.04	495.84	502.71	509.67	538.36	584.04	624.72	713.84
Farm Employment	0.5%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.5%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Mining	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Utilities	0.3%	0.5%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%
Construction	9.0%	6.1%	6.1%	6.3%	6.2%	6.2%	6.2%	6.0%	5.8%	5.6%	5.2%
Manufacturing	3.4%	3.0%	3.0%	3.1%	3.0%	2.9%	2.9%	2.6%	2.3%	2.1%	1.6%
Wholesale Trade	2.6%	2.2%	2.1%	2.1%	2.1%	2.1%	2.1%	2.0%	1.9%	1.9%	1.7%
Retail Trade	12.0%	11.3%	11.1%	11.1%	11.1%	11.0%	11.0%	10.9%	10.6%	10.4%	10.0%
Transportation and Warehousing	1.8%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.6%	1.5%	1.4%
Information Employment	1.9%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%	1.3%	1.2%
Finance and Insurance	3.6%	4.4%	4.5%	4.2%	4.3%	4.3%	4.3%	4.4%	4.5%	4.7%	4.8%
Real Estate/Rental and Lease	5.5%	5.4%	5.4%	5.3%	5.3%	5.3%	5.3%	5.4%	5.4%	5.5%	5.5%
Professional and Technical Services	5.2%	5.8%	6.0%	6.1%	6.2%	6.3%	6.4%	6.8%	7.3%	7.8%	8.8%
Management	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Administrative and Waste Services	7.0%	6.6%	6.5%	6.4%	6.5%	6.5%	6.5%	6.7%	6.9%	7.1%	7.5%
Educational Services	1.0%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%

Table 4-10. Demographic and Employment Baseline Projections for Economic Impact Area FL-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	8.9%	10.2%	10.4%	10.5%	10.7%	10.8%	10.9%	11.4%	12.1%	12.7%	14.0%
Arts, Entertainment, and Recreation	1.7%	2.0%	2.0%	2.1%	2.1%	2.2%	2.2%	2.3%	2.4%	2.5%	2.7%
Accommodation and Food Services	8.8%	9.4%	9.5%	9.5%	9.5%	9.6%	9.6%	9.6%	9.6%	9.6%	9.5%
Other Services, Except Public Administration	6.2%	6.2%	6.2%	6.2%	6.3%	6.3%	6.3%	6.5%	6.6%	6.8%	7.0%
Federal Civilian Government	3.5%	4.0%	4.0%	4.1%	4.0%	4.0%	3.9%	3.8%	3.5%	3.3%	2.9%
Federal Military	6.9%	7.0%	6.9%	6.8%	6.7%	6.6%	6.6%	6.2%	5.8%	5.4%	4.8%
State and Local Government	9.1%	9.6%	9.4%	9.2%	9.1%	9.1%	9.0%	8.8%	8.4%	8.1%	7.5%
Total Earnings (in millions of 2005 dollars)	19,144.97	18,884.77	19,048.20	19,025.90	19,536.31	19,997.79	20,469.77	22,467.72	25,823.44	28,988.08	36,494.20
Farm	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Forestry, Fishing, Related Activities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Utilities	0.5%	0.9%	1.1%	1.3%	1.1%	1.1%	1.2%	1.2%	1.4%	1.5%	1.7%
Construction	8.1%	5.5%	5.5%	5.8%	5.7%	5.6%	5.5%	5.2%	4.8%	4.5%	3.8%
Manufacturing	4.8%	4.2%	4.1%	4.1%	4.1%	4.0%	3.9%	3.7%	3.3%	3.0%	2.5%
Wholesale Trade	3.0%	2.7%	2.6%	2.6%	2.6%	2.6%	2.6%	2.5%	2.5%	2.4%	2.3%
Retail Trade	7.9%	7.0%	7.0%	7.1%	7.0%	6.9%	6.8%	6.5%	6.0%	5.6%	4.9%
Transportation and Warehousing	1.8%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.5%	1.4%	1.4%	1.2%
Information	2.4%	1.9%	1.9%	1.8%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%	1.9%
Finance and Insurance	3.9%	3.8%	3.8%	3.6%	3.6%	3.7%	3.7%	3.8%	3.9%	4.0%	4.2%
Real Estate/Rental and Lease	3.1%	1.8%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
Professional and Technical Services	6.6%	7.5%	7.7%	7.8%	7.9%	8.1%	8.2%	8.7%	9.6%	10.3%	11.9%
Management	0.8%	0.4%	0.3%	0.3%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%
Administrative and Waste Services	4.5%	4.1%	4.1%	4.0%	4.1%	4.1%	4.2%	4.3%	4.5%	4.7%	5.0%
Educational Services	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%
Health Care and Social Assistance	10.0%	11.5%	11.6%	11.8%	11.9%	12.0%	12.2%	12.7%	13.6%	14.3%	15.8%
Arts, Entertainment, and Recreation	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%
Accommodation and Food Services	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.5%
Other Services, Except Public Administration	4.4%	4.0%	4.0%	4.1%	4.1%	4.1%	4.1%	4.2%	4.2%	4.3%	4.3%
Federal Civilian Government	6.8%	8.2%	8.1%	8.1%	8.1%	8.0%	8.0%	7.9%	7.6%	7.4%	7.0%
Federal Military	14.5%	17.1%	16.9%	16.7%	16.7%	16.7%	16.6%	16.4%	16.1%	15.9%	15.3%
State and Local Government	10.5%	11.3%	11.0%	10.6%	10.5%	10.5%	10.5%	10.3%	10.0%	9.7%	9.2%
Total Personal Income per Capita (in 2005 dollars)	31,073	32,385	32,979	32,765	32,929	33,163	33,486	35,242	38,588	41,917	50,041
Woods & Poole Economics Wealth Index (U.S. = 100)	85.9	86.8	86.4	85.5	85.5	85.4	85.3	85.2	85.2	85.2	85.3
Persons per Household (in number of people)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table 4-10. Demographic and Employment Baseline Projections for Economic Impact Area FL-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	78,593	82,502	83,713	82,744	82,738	82,886	83,286	86,728	95,078	104,101	126,566
Number of Households (in thousands)	340.73	346.54	350.54	356.67	362.90	369.34	375.70	398.40	426.33	446.38	484.04
Income <$10,000 (thousands of households, 2000$)	8.6%	7.7%	7.6%	7.5%	7.4%	7.3%	7.2%	6.6%	5.5%	4.7%	3.4%
Income $10,000 to $19,999	12.3%	11.1%	10.8%	10.8%	10.6%	10.5%	10.3%	9.4%	7.9%	6.8%	4.9%
Income $20,000 to $29,999	13.7%	12.4%	12.1%	12.0%	11.8%	11.7%	11.5%	10.5%	8.8%	7.6%	5.5%
Income $30,000 to $44,999	19.6%	18.3%	17.9%	17.8%	17.6%	17.3%	17.1%	15.6%	13.1%	11.3%	8.2%
Income $45,000 to $59,999	16.6%	18.1%	18.4%	18.5%	18.7%	18.8%	19.0%	19.6%	18.8%	16.7%	12.2%
Income $60,000 to $74,999	11.3%	12.5%	12.8%	13.0%	13.1%	13.3%	13.5%	14.8%	17.7%	20.1%	20.2%
Income $75,000 to $99,999	9.3%	10.2%	10.5%	10.6%	10.7%	10.9%	11.0%	12.1%	14.5%	16.8%	23.4%
Income $100,000 or more	8.7%	9.6%	9.9%	10.0%	10.1%	10.2%	10.4%	11.4%	13.7%	15.9%	22.2%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-11

Demographic and Employment Baseline Projections for Economic Impact Area FL-2

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	619.13	659.96	661.80	670.02	678.38	686.86	695.39	730.00	782.71	826.55	913.81
Age Under 19 Years	26.0%	24.9%	24.7%	23.9%	23.6%	23.6%	23.6%	23.8%	23.6%	23.3%	22.6%
Age 20 to 34	24.1%	24.2%	24.4%	24.9%	25.0%	24.7%	24.2%	22.6%	20.1%	19.1%	19.7%
Age 35 to 49	20.5%	18.9%	18.5%	18.2%	17.9%	17.8%	17.8%	18.4%	20.1%	21.0%	17.9%
Age 50 to 64	17.6%	19.2%	19.3%	19.3%	19.3%	19.4%	19.3%	18.5%	17.1%	16.3%	19.0%
Age 65 and over	11.8%	12.8%	13.2%	13.7%	14.1%	14.5%	15.0%	16.7%	19.0%	20.3%	20.9%
Median Age of Population (years)	37.9	39.3	39.4	39.7	39.9	40.0	40.2	40.8	41.8	42.7	43.6
White Population (in thousands)	66.7%	65.0%	64.6%	64.5%	64.3%	64.1%	63.9%	63.2%	61.9%	60.8%	58.6%
Black Population (in thousands)	26.8%	27.2%	27.2%	27.2%	27.3%	27.3%	27.4%	27.7%	28.3%	28.8%	29.8%
Native American Population (in thousands)	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%
Asian and Pacific Islander Population (in thousands)	1.5%	1.7%	1.8%	1.8%	1.8%	1.9%	1.9%	2.0%	2.1%	2.2%	2.3%
Hispanic or Latino Population (in thousands)	4.6%	5.7%	5.9%	6.0%	6.1%	6.2%	6.3%	6.7%	7.2%	7.8%	8.8%
Male Population (in thousands)	50.4%	50.9%	50.8%	50.9%	51.0%	51.1%	51.1%	51.4%	51.7%	51.8%	52.1%
Total Employment (in thousands of jobs)	322.62	322.32	323.02	324.07	328.11	332.19	336.31	353.35	380.57	404.92	458.68
Farm Employment	2.6%	2.9%	2.9%	2.9%	2.9%	2.8%	2.8%	2.7%	2.6%	2.5%	2.3%
Forestry, Fishing, Related Activities	1.3%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%
Mining	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Construction	6.5%	4.9%	4.8%	5.0%	5.0%	5.0%	5.0%	4.9%	4.9%	4.8%	4.7%
Manufacturing	4.6%	3.7%	3.8%	3.9%	3.8%	3.8%	3.7%	3.6%	3.3%	3.1%	2.7%
Wholesale Trade	2.1%	2.0%	2.0%	2.2%	2.2%	2.1%	2.1%	2.1%	2.0%	2.0%	1.9%
Retail Trade	11.0%	9.9%	9.9%	10.0%	10.0%	10.0%	10.0%	10.0%	9.9%	9.8%	9.7%
Transportation and Warehousing	1.6%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Information Employment	1.8%	1.5%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%	1.2%	1.2%
Finance and Insurance	3.2%	3.9%	3.9%	3.8%	3.8%	3.8%	3.8%	3.8%	3.9%	3.9%	4.0%
Real Estate/Rental and Lease	3.1%	3.1%	3.1%	3.0%	3.0%	3.0%	3.1%	3.1%	3.2%	3.2%	3.2%
Professional and Technical Services	5.8%	6.0%	5.8%	5.7%	5.7%	5.8%	5.8%	5.9%	6.1%	6.3%	6.5%
Management	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Administrative and Waste Services	4.8%	4.8%	4.7%	4.8%	4.8%	4.8%	4.9%	5.0%	5.3%	5.4%	5.8%
Educational Services	1.1%	1.5%	1.5%	1.5%	1.5%	1.5%	1.6%	1.7%	1.9%	2.1%	2.5%

Table 4-11. Demographic and Employment Baseline Projections for Economic Impact Area FL-2 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	8.6%	10.0%	10.2%	10.3%	10.4%	10.5%	10.7%	11.2%	12.1%	12.8%	14.4%
Arts, Entertainment, and Recreation	1.2%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.6%	1.7%
Accommodation and Food Services	6.6%	6.8%	6.8%	6.7%	6.7%	6.7%	6.8%	6.8%	6.9%	6.9%	7.0%
Other Services, Except Public Administration	6.2%	6.1%	6.2%	6.2%	6.2%	6.2%	6.2%	6.3%	6.4%	6.5%	6.5%
Federal Civilian Government	1.2%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.2%	1.2%	1.0%
Federal Military	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
State and Local Government	25.3%	26.1%	26.1%	25.9%	25.7%	25.6%	25.4%	24.7%	23.7%	22.8%	21.2%
Total Earnings (in millions of 2005 dollars)	11,927.62	11,830.85	11,712.99	11,626.75	11,900.96	12,162.84	12,430.40	13,560.23	15,449.18	17,222.67	21,408.09
Farm	1.3%	1.2%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%	1.1%	1.0%
Forestry, Fishing, Related Activities	1.3%	1.4%	1.4%	1.4%	1.5%	1.5%	1.4%	1.4%	1.3%	1.3%	1.2%
Mining	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Utilities	0.8%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	0.6%	0.6%
Construction	6.4%	4.5%	4.4%	4.5%	4.5%	4.4%	4.4%	4.3%	4.0%	3.9%	3.5%
Manufacturing	5.9%	5.3%	5.4%	5.5%	5.4%	5.4%	5.3%	5.2%	5.0%	4.8%	4.5%
Wholesale Trade	2.7%	2.4%	2.5%	2.6%	2.7%	2.7%	2.6%	2.6%	2.6%	2.5%	2.4%
Retail Trade	7.2%	6.8%	6.9%	7.1%	7.0%	6.9%	6.9%	6.6%	6.2%	5.9%	5.3%
Transportation and Warehousing	1.5%	1.1%	1.1%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%
Information	2.4%	2.0%	1.9%	1.9%	1.8%	1.9%	1.9%	1.9%	1.9%	1.9%	2.0%
Finance and Insurance	4.2%	4.3%	4.3%	4.2%	4.2%	4.3%	4.3%	4.4%	4.5%	4.6%	4.7%
Real Estate/Rental and Lease	1.1%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Professional and Technical Services	7.9%	8.2%	8.2%	8.2%	8.2%	8.3%	8.3%	8.6%	9.1%	9.5%	10.3%
Management	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Administrative and Waste Services	2.8%	2.9%	3.0%	3.2%	3.2%	3.2%	3.3%	3.4%	3.6%	3.8%	4.1%
Educational Services	0.5%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.9%	1.0%	1.2%
Health Care and Social Assistance	9.5%	11.3%	11.5%	11.7%	11.8%	12.0%	12.1%	12.8%	13.8%	14.7%	16.5%
Arts, Entertainment, and Recreation	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Accommodation and Food Services	2.7%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
Other Services, Except Public Administration	5.2%	5.1%	5.2%	5.2%	5.2%	5.2%	5.2%	5.3%	5.3%	5.3%	5.3%
Federal Civilian Government	2.7%	3.2%	3.1%	3.1%	3.1%	3.1%	3.1%	3.0%	2.9%	2.9%	2.7%
Federal Military	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
State and Local Government	32.3%	34.1%	33.5%	32.9%	32.7%	32.5%	32.4%	31.8%	30.9%	30.1%	28.6%
Total Personal Income per Capita (in 2005 dollars)	26,967	26,978	27,107	26,654	26,837	27,090	27,407	29,022	32,034	35,017	42,303
Woods & Poole Economics Wealth Index (U.S. = 100)	66.4	66.8	66.0	64.9	65.1	65.1	65.1	65.1	65.0	65.0	64.9
Persons per Household (in number of people)	2.6	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7

Table 4-11. Demographic and Employment Baseline Projections for Economic Impact Area FL-2 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	70,426	71,664	71,763	70,245	70,421	70,757	71,281	74,883	83,068	91,805	113,624
Number of Households (in thousands)	237.07	248.45	249.98	254.23	258.53	262.97	267.37	282.92	301.84	315.27	340.21
Income <$10,000 (thousands of households, 2000$)	13.7%	12.6%	12.4%	12.4%	12.2%	12.0%	11.8%	10.9%	9.2%	7.9%	5.9%
Income $10,000 to $19,999	14.3%	13.2%	13.0%	13.0%	12.7%	12.6%	12.4%	11.4%	9.6%	8.3%	6.1%
Income $20,000 to $29,999	13.9%	12.9%	12.7%	12.6%	12.4%	12.2%	12.1%	11.1%	9.4%	8.1%	6.0%
Income $30,000 to $44,999	18.7%	18.7%	18.7%	18.7%	18.6%	18.4%	18.3%	17.4%	15.0%	12.9%	9.4%
Income $45,000 to $59,999	14.1%	15.3%	15.6%	15.6%	15.9%	16.1%	16.4%	17.6%	19.3%	19.2%	15.5%
Income $60,000 to $74,999	9.3%	10.1%	10.3%	10.3%	10.5%	10.6%	10.8%	11.8%	13.9%	16.3%	20.0%
Income $75,000 to $99,999	8.1%	8.8%	8.9%	8.9%	9.1%	9.2%	9.4%	10.2%	12.1%	14.1%	19.3%
Income $100,000 or more	7.7%	8.3%	8.5%	8.5%	8.6%	8.8%	8.9%	9.7%	11.4%	13.2%	18.0%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-12

Demographic and Employment Baseline Projections for Economic Impact Area FL-3

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	3,435.22	3,626.40	3,663.94	3,721.36	3,779.50	3,838.27	3,897.31	4,136.02	4,498.17	4,799.12	5,397.92
Age Under 19 Years	23.9%	23.2%	22.8%	22.7%	22.6%	22.5%	22.5%	22.5%	22.6%	22.6%	22.9%
Age 20 to 34	18.5%	18.6%	18.9%	19.1%	19.2%	19.2%	19.2%	18.9%	18.3%	18.0%	18.4%
Age 35 to 49	21.3%	19.8%	19.4%	18.9%	18.6%	18.2%	18.0%	17.6%	17.8%	18.3%	17.7%
Age 50 to 64	18.5%	20.2%	20.6%	20.7%	20.7%	20.8%	20.8%	20.3%	18.6%	16.9%	16.8%
Age 65 and over	17.8%	18.2%	18.3%	18.6%	18.9%	19.2%	19.5%	20.6%	22.8%	24.2%	24.2%
Median Age of Population (years)	41.7	42.9	43.3	43.5	43.7	43.8	44.0	44.4	44.6	44.8	44.7
White Population (in thousands)	73.9%	70.0%	69.4%	68.9%	68.4%	67.8%	67.3%	65.2%	62.0%	59.2%	53.5%
Black Population (in thousands)	11.4%	12.0%	12.3%	12.4%	12.4%	12.5%	12.6%	12.8%	13.2%	13.4%	13.8%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Asian and Pacific Islander Population (in thousands)	2.6%	3.1%	3.2%	3.3%	3.3%	3.4%	3.5%	3.8%	4.2%	4.6%	5.4%
Hispanic or Latino Population (in thousands)	11.8%	14.5%	14.8%	15.2%	15.6%	15.9%	16.3%	17.9%	20.4%	22.5%	27.1%
Male Population (in thousands)	48.6%	48.6%	48.6%	48.6%	48.7%	48.7%	48.7%	48.8%	48.9%	48.9%	48.9%
Total Employment (in thousands of jobs)	1,944.15	1,842.54	1,880.65	1,915.18	1,945.11	1,975.41	2,006.07	2,132.46	2,333.86	2,513.15	2,905.81
Farm Employment	1.0%	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Mining	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%
Construction	7.3%	5.1%	4.8%	4.9%	4.9%	4.9%	4.9%	4.9%	5.0%	5.1%	5.2%
Manufacturing	5.0%	4.1%	4.2%	4.2%	4.2%	4.1%	4.0%	3.8%	3.5%	3.2%	2.7%
Wholesale Trade	3.4%	3.2%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.0%	3.0%	2.9%
Retail Trade	11.4%	11.2%	11.3%	11.6%	11.7%	11.7%	11.7%	11.8%	12.0%	12.1%	12.2%
Transportation and Warehousing	2.3%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Information Employment	2.2%	1.9%	1.8%	1.8%	1.8%	1.8%	1.8%	1.7%	1.7%	1.6%	1.5%
Finance and Insurance	5.8%	6.8%	6.9%	6.6%	6.6%	6.6%	6.5%	6.5%	6.3%	6.2%	5.9%
Real Estate/Rental and Lease	4.5%	4.4%	4.4%	4.2%	4.2%	4.2%	4.1%	4.1%	4.0%	3.9%	3.7%
Professional and Technical Services	6.4%	7.2%	7.2%	7.3%	7.3%	7.3%	7.3%	7.3%	7.2%	7.2%	7.1%
Management	0.8%	1.2%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.6%
Administrative and Waste Services	10.8%	7.9%	7.7%	7.7%	7.7%	7.7%	7.7%	7.6%	7.6%	7.5%	7.4%
Educational Services	1.3%	1.8%	1.9%	1.9%	1.9%	1.9%	2.0%	2.1%	2.4%	2.7%	3.2%
Health Care and Social Assistance	10.3%	12.3%	12.5%	12.5%	12.6%	12.7%	12.8%	13.2%	13.7%	14.2%	15.1%

Table 4-12. Demographic and Employment Baseline Projections for Economic Impact Area FL-3 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Arts, Entertainment, and Recreation	2.0%	2.4%	2.5%	2.6%	2.7%	2.7%	2.7%	2.8%	3.0%	3.1%	3.4%
Accommodation and Food Services	6.8%	7.1%	7.2%	7.3%	7.2%	7.2%	7.2%	7.0%	6.8%	6.6%	6.2%
Other Services, Except Public Administration	5.9%	6.0%	6.0%	6.0%	6.0%	6.0%	6.1%	6.3%	6.5%	6.8%	7.3%
Federal Civilian Government	1.3%	1.6%	1.6%	1.7%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.5%
Federal Military	0.7%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.6%	0.6%	0.5%
State and Local Government	9.9%	10.6%	10.4%	10.2%	10.1%	10.1%	10.0%	9.8%	9.4%	9.1%	8.5%
Total Earnings (in millions of 2005 dollars)	79,115.35	75,206.53	75,733.42	76,242.07	78,415.64	80,420.58	82,471.24	91,149.87	105,706.84	119,398.09	151,682.46
Farm	0.5%	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Forestry, Fishing, Related Activities	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	0.3%	0.1%	0.1%	0.1%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%
Utilities	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Construction	7.5%	4.8%	4.5%	4.5%	4.4%	4.4%	4.4%	4.3%	4.2%	4.1%	3.8%
Manufacturing	6.8%	6.1%	6.2%	6.3%	6.3%	6.2%	6.2%	5.9%	5.6%	5.3%	4.8%
Wholesale Trade	4.9%	4.8%	4.7%	4.7%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.5%
Retail Trade	8.3%	7.8%	7.9%	8.2%	8.1%	8.1%	8.0%	7.8%	7.4%	7.1%	6.5%
Transportation and Warehousing	2.2%	2.1%	2.2%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%	1.9%	1.8%
Information	3.3%	3.0%	2.9%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.8%	2.8%
Finance and Insurance	8.0%	7.8%	7.8%	7.5%	7.5%	7.5%	7.5%	7.4%	7.2%	7.1%	6.8%
Real Estate/Rental and Lease	2.3%	1.5%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%
Professional and Technical Services	8.1%	9.7%	10.0%	10.1%	10.1%	10.1%	10.2%	10.3%	10.4%	10.5%	10.7%
Management	1.6%	2.3%	2.5%	2.8%	2.8%	2.9%	2.9%	3.1%	3.3%	3.5%	3.9%
Administrative and Waste Services	7.1%	5.2%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Educational Services	0.8%	1.2%	1.3%	1.3%	1.3%	1.4%	1.4%	1.5%	1.8%	2.0%	2.5%
Health Care and Social Assistance	12.1%	14.6%	14.6%	14.6%	14.7%	14.8%	14.9%	15.3%	16.0%	16.6%	17.7%
Arts, Entertainment, and Recreation	1.5%	1.8%	1.9%	2.0%	2.0%	2.0%	2.0%	2.1%	2.2%	2.3%	2.4%
Accommodation and Food Services	3.9%	3.7%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%	3.6%	3.5%	3.3%
Other Services, Except Public Administration	4.0%	3.8%	3.8%	3.7%	3.7%	3.8%	3.8%	3.8%	4.0%	4.0%	4.2%
Federal Civilian Government	2.7%	3.5%	3.5%	3.4%	3.4%	3.4%	3.4%	3.5%	3.6%	3.6%	3.7%
Federal Military	1.2%	1.6%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%
State and Local Government	11.8%	13.2%	13.0%	12.6%	12.5%	12.5%	12.4%	12.3%	11.9%	11.7%	11.2%
Total Personal Income per Capita (in 2005 dollars)	33,038	32,184	32,448	32,086	32,189	32,388	32,679	34,329	37,521	40,713	48,510
Woods & Poole Economics Wealth Index (U.S. = 100)	78.9	77.6	76.9	75.6	75.8	75.8	75.8	76.0	76.2	76.3	76.6

Table 4-12. Demographic and Employment Baseline Projections for Economic Impact Area FL-3 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Persons per Household (in number of people)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.4	2.4	2.4
Mean Household Total Personal Income (in 2005 dollars)	78,298	77,951	78,338	77,085	76,977	77,075	77,425	80,614	88,451	96,951	118,165
Number of Households (in thousands)	1,449.50	1,497.25	1,517.61	1,549.00	1,580.47	1,612.89	1,644.98	1,761.29	1,908.13	2,015.30	2,216.00
Income <$10,000 (thousands of households, 2000$)	9.0%	8.4%	8.3%	8.2%	8.1%	8.0%	7.9%	7.2%	6.1%	5.3%	4.0%
Income $10,000 to $19,999	13.6%	12.8%	12.5%	12.4%	12.3%	12.1%	11.9%	10.9%	9.2%	8.0%	6.0%
Income $20,000 to $29,999	14.5%	13.6%	13.3%	13.3%	13.1%	12.9%	12.7%	11.7%	9.9%	8.5%	6.4%
Income $30,000 to $44,999	19.6%	19.1%	18.8%	18.8%	18.6%	18.4%	18.3%	17.0%	14.4%	12.5%	9.4%
Income $45,000 to $59,999	15.3%	16.3%	16.7%	16.7%	17.0%	17.2%	17.4%	18.5%	19.4%	18.3%	14.2%
Income $60,000 to $74,999	9.9%	10.6%	10.8%	10.8%	11.0%	11.1%	11.3%	12.3%	14.6%	16.9%	19.5%
Income $75,000 to $99,999	8.5%	9.1%	9.3%	9.3%	9.5%	9.6%	9.7%	10.6%	12.5%	14.5%	19.3%
Income $100,000 or more	9.6%	10.1%	10.4%	10.4%	10.6%	10.7%	10.8%	11.7%	13.8%	16.0%	21.2%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-13

Demographic and Employment Baseline Projections for Economic Impact Area FL-4

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	5,934.95	6,170.12	6,273.04	6,360.03	6,448.27	6,537.57	6,627.34	6,990.77	7,542.74	8,001.19	8,912.76
Age Under 19 Years	24.4%	23.3%	23.0%	22.8%	22.7%	22.6%	22.5%	22.3%	22.0%	21.9%	21.6%
Age 20 to 34	18.4%	18.3%	18.6%	18.6%	18.7%	18.8%	18.8%	18.6%	17.9%	17.3%	17.3%
Age 35 to 49	22.2%	21.1%	20.7%	20.3%	19.9%	19.5%	19.2%	18.5%	18.2%	18.5%	17.6%
Age 50 to 64	17.8%	19.4%	19.7%	19.8%	19.9%	20.1%	20.2%	20.1%	19.2%	17.6%	16.8%
Age 65 and over	17.1%	17.9%	18.1%	18.4%	18.8%	19.0%	19.4%	20.6%	22.7%	24.7%	26.6%
Median Age of Population (years)	44.0	45.5	45.9	46.0	46.2	46.3	46.4	46.9	46.9	46.9	46.6
White Population (in thousands)	45.8%	42.3%	42.1%	41.6%	41.1%	40.6%	40.1%	38.3%	35.6%	33.4%	29.3%
Black Population (in thousands)	16.7%	16.7%	16.8%	16.8%	16.8%	16.8%	16.9%	16.9%	17.0%	17.1%	17.2%
Native American Population (in thousands)	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
Asian and Pacific Islander Population (in thousands)	2.0%	2.2%	2.2%	2.3%	2.3%	2.4%	2.4%	2.5%	2.7%	2.9%	3.1%
Hispanic or Latino Population (in thousands)	35.3%	38.6%	38.7%	39.2%	39.6%	40.0%	40.5%	42.1%	44.4%	46.5%	50.2%
Male Population (in thousands)	48.6%	48.6%	48.7%	48.7%	48.7%	48.7%	48.7%	48.7%	48.7%	48.6%	48.4%
Total Employment (in thousands of jobs)	3,395.35	3,351.08	3,452.11	3,548.46	3,610.06	3,672.52	3,735.84	3,997.92	4,418.49	4,795.40	5,626.66
Farm Employment	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Forestry, Fishing, Related Activities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Mining	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%
Utilities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
Construction	8.0%	5.0%	4.8%	4.7%	4.7%	4.7%	4.7%	4.8%	4.8%	4.9%	4.9%
Manufacturing	3.6%	2.8%	2.7%	2.8%	2.7%	2.6%	2.6%	2.4%	2.1%	1.9%	1.6%
Wholesale Trade	4.5%	4.3%	4.3%	4.5%	4.4%	4.4%	4.4%	4.3%	4.1%	4.0%	3.7%
Retail Trade	11.2%	11.1%	11.2%	11.4%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.4%
Transportation and Warehousing	3.8%	3.7%	3.8%	3.7%	3.7%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Information Employment	2.0%	1.6%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%	1.4%	1.3%
Finance and Insurance	5.0%	6.1%	6.3%	6.1%	6.1%	6.1%	6.1%	6.1%	6.0%	6.0%	6.0%
Real Estate/Rental and Lease	6.0%	6.2%	6.2%	6.0%	6.0%	6.0%	6.0%	5.9%	5.9%	5.8%	5.8%
Professional and Technical Services	6.5%	7.0%	7.0%	7.1%	7.1%	7.1%	7.2%	7.2%	7.3%	7.3%	7.4%
Management	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%
Administrative and Waste Services	9.0%	8.1%	8.1%	8.2%	8.3%	8.3%	8.4%	8.6%	9.0%	9.3%	9.9%
Educational Services	1.8%	2.4%	2.5%	2.4%	2.4%	2.5%	2.5%	2.6%	2.7%	2.8%	3.0%
Health Care and Social Assistance	9.1%	10.7%	10.7%	10.7%	10.7%	10.8%	10.8%	11.1%	11.4%	11.6%	12.1%

Table 4-13. Demographic and Employment Baseline Projections for Economic Impact Area FL-4 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Arts, Entertainment, and Recreation	2.2%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.3%
Accommodation and Food Services	7.2%	7.7%	7.9%	8.2%	8.2%	8.1%	8.1%	8.1%	8.1%	8.0%	8.0%
Other Services, Except Public Administration	7.7%	8.1%	8.1%	8.1%	8.1%	8.2%	8.2%	8.3%	8.5%	8.6%	8.9%
Federal Civilian Government	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%
Federal Military	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.3%
State and Local Government	9.0%	9.0%	8.7%	8.4%	8.3%	8.3%	8.2%	8.0%	7.6%	7.3%	6.7%
Total Earnings (in millions of 2005 dollars)	146,349.28	135,702.12	137,788.29	140,117.22	143,722.21	147,475.18	151,316.36	167,601.21	195,009.39	220,880.16	282,175.15
Farm	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.3%
Forestry, Fishing, Related Activities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Utilities	0.4%	0.5%	0.5%	0.4%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%
Construction	9.4%	5.6%	5.3%	5.2%	5.2%	5.2%	5.1%	5.0%	4.9%	4.8%	4.5%
Manufacturing	4.4%	3.8%	3.8%	3.9%	3.9%	3.8%	3.8%	3.6%	3.3%	3.1%	2.7%
Wholesale Trade	6.8%	7.1%	7.2%	7.5%	7.4%	7.4%	7.4%	7.3%	7.1%	6.9%	6.6%
Retail Trade	8.5%	8.3%	8.4%	8.7%	8.6%	8.6%	8.5%	8.2%	7.8%	7.5%	6.8%
Transportation and Warehousing	4.0%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.0%	3.9%	3.9%	3.7%
Information	3.6%	3.1%	3.2%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.4%
Finance and Insurance	6.9%	6.8%	6.9%	6.7%	6.6%	6.6%	6.6%	6.7%	6.7%	6.7%	6.7%
Real Estate/Rental and Lease	3.7%	2.1%	2.1%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.8%	1.8%
Professional and Technical Services	8.3%	9.6%	9.8%	10.0%	10.1%	10.2%	10.2%	10.5%	10.8%	11.1%	11.7%
Management	1.3%	1.8%	1.8%	1.8%	1.8%	1.8%	1.9%	2.0%	2.2%	2.4%	2.8%
Administrative and Waste Services	6.2%	5.0%	5.0%	5.2%	5.2%	5.3%	5.3%	5.5%	5.8%	6.0%	6.5%
Educational Services	1.5%	2.1%	2.1%	2.0%	2.0%	2.0%	2.1%	2.2%	2.3%	2.4%	2.7%
Health Care and Social Assistance	9.5%	12.0%	11.9%	11.9%	12.0%	12.0%	12.1%	12.5%	12.9%	13.3%	14.1%
Arts, Entertainment, and Recreation	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%
Accommodation and Food Services	4.3%	4.7%	4.9%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.0%
Other Services, Except Public Administration	4.2%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.7%	4.8%	4.8%	5.0%
Federal Civilian Government	2.2%	2.6%	2.5%	2.5%	2.5%	2.5%	2.5%	2.4%	2.4%	2.4%	2.3%
Federal Military	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%
State and Local Government	11.8%	13.3%	12.7%	12.1%	12.0%	12.0%	11.9%	11.7%	11.4%	11.1%	10.5%
Total Personal Income per Capita (in 2005 dollars)	37,492	36,585	36,920	36,834	36,830	37,094	37,486	39,719	44,049	48,404	59,208
Woods & Poole Economics Wealth Index (U.S. = 100)	118.7	115.0	114.1	112.9	112.7	112.6	112.6	113.3	114.9	116.4	119.8
Persons per Household (in number of people)	2.5	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.6
Mean Household Total Personal Income (in 2005 dollars)	94,609	94,796	95,361	94,651	94,174	94,359	94,905	99,547	110,629	122,624	152,996

Table 4-13. Demographic and Employment Baseline Projections for Economic Impact Area FL-4 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Number of Households (in thousands)	2,351.92	2,381.27	2,428.65	2,475.06	2,521.79	2,570.01	2,617.71	2,789.28	3,003.29	3,158.35	3,449.13
Income <$10,000 (thousands of households, 2000$)	9.1%	8.5%	8.4%	8.3%	8.2%	8.1%	8.0%	7.4%	6.3%	5.6%	4.2%
Income $10,000 to $19,999	12.1%	11.3%	11.2%	11.1%	11.0%	10.8%	10.7%	9.9%	8.5%	7.4%	5.6%
Income $20,000 to $29,999	12.6%	11.9%	11.7%	11.6%	11.5%	11.4%	11.2%	10.3%	8.9%	7.8%	5.8%
Income $30,000 to $44,999	17.3%	16.5%	16.3%	16.2%	16.0%	15.8%	15.6%	14.4%	12.4%	10.9%	8.1%
Income $45,000 to $59,999	15.0%	15.7%	15.9%	16.0%	16.1%	16.2%	16.3%	16.6%	15.7%	14.0%	10.5%
Income $60,000 to $74,999	10.7%	11.3%	11.5%	11.6%	11.7%	11.9%	12.0%	13.1%	15.1%	16.5%	15.2%
Income $75,000 to $99,999	10.1%	10.7%	10.8%	10.9%	11.0%	11.2%	11.3%	12.3%	14.3%	16.4%	21.5%
Income $100,000 or more	13.2%	14.0%	14.2%	14.3%	14.4%	14.6%	14.8%	16.1%	18.8%	21.4%	29.1%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-14

Demographic and Employment Baseline Projections for Economic Impact Area LA-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	338.48	346.02	346.51	349.64	352.85	356.11	359.40	372.82	393.34	410.37	444.18
Age Under 19 Years	29.3%	28.5%	28.0%	28.2%	28.3%	28.3%	28.3%	28.7%	28.9%	28.5%	27.5%
Age 20 to 34	21.6%	21.3%	21.5%	21.2%	20.9%	20.7%	20.4%	18.9%	17.9%	18.3%	19.6%
Age 35 to 49	20.9%	19.3%	19.0%	18.8%	18.6%	18.5%	18.5%	19.0%	19.3%	18.5%	16.6%
Age 50 to 64	16.4%	18.5%	18.9%	18.9%	19.1%	19.2%	19.2%	18.7%	17.2%	16.8%	18.0%
Age 65 and over	11.8%	12.4%	12.6%	12.9%	13.1%	13.3%	13.5%	14.6%	16.7%	17.9%	18.3%
Median Age of Population (years)	34.9	36.2	36.3	36.4	36.5	36.6	36.8	37.4	38.0	38.2	38.4
White Population (in thousands)	74.8%	73.4%	73.0%	72.8%	72.7%	72.6%	72.5%	72.1%	71.4%	70.7%	69.3%
Black Population (in thousands)	20.7%	21.4%	21.6%	21.6%	21.6%	21.6%	21.6%	21.6%	21.6%	21.6%	21.5%
Native American Population (in thousands)	0.7%	0.9%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Asian and Pacific Islander Population (in thousands)	1.0%	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.4%	1.6%	1.7%	1.9%
Hispanic or Latino Population (in thousands)	2.7%	3.1%	3.3%	3.4%	3.5%	3.6%	3.7%	4.0%	4.6%	5.2%	6.4%
Male Population (in thousands)	50.0%	50.0%	49.9%	49.9%	50.0%	50.0%	50.0%	50.1%	50.1%	50.1%	50.1%
Total Employment (in thousands of jobs)	171.64	177.41	175.82	175.74	177.96	180.22	182.51	191.90	206.92	220.30	249.67
Farm Employment	1.9%	2.0%	2.0%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.7%	1.6%
Forestry, Fishing, Related Activities	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	1.1%
Mining	1.1%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.0%	0.9%
Utilities	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.2%
Construction	8.7%	8.0%	7.6%	7.4%	7.4%	7.4%	7.5%	7.6%	7.7%	7.8%	7.9%
Manufacturing	6.7%	6.5%	6.8%	7.2%	7.0%	6.8%	6.7%	6.0%	5.2%	4.6%	3.5%
Wholesale Trade	2.2%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%	1.9%	1.8%
Retail Trade	11.0%	10.3%	10.2%	10.2%	10.3%	10.3%	10.4%	10.5%	10.8%	10.9%	11.2%
Transportation and Warehousing	3.2%	2.8%	2.8%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
Information Employment	1.0%	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.6%
Finance and Insurance	2.5%	3.0%	3.2%	3.0%	3.0%	3.0%	2.9%	2.9%	2.8%	2.7%	2.5%
Real Estate/Rental and Lease	2.4%	2.8%	2.9%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.7%
Professional and Technical Services	4.7%	4.2%	4.2%	4.2%	4.3%	4.3%	4.3%	4.5%	4.7%	4.9%	5.3%
Management	0.7%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Administrative and Waste Services	3.8%	4.3%	4.3%	4.3%	4.3%	4.4%	4.4%	4.6%	4.8%	5.0%	5.4%
Educational Services	1.0%	1.1%	1.2%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%
Health Care and Social Assistance	9.5%	10.4%	10.4%	10.2%	10.4%	10.5%	10.7%	11.3%	12.2%	13.0%	14.6%

Table 4-14. Demographic and Employment Baseline Projections for Economic Impact Area LA-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Arts, Entertainment, and Recreation	2.3%	1.4%	1.4%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%	1.0%
Accommodation and Food Services	7.9%	7.8%	8.0%	8.1%	8.2%	8.2%	8.3%	8.4%	8.7%	8.9%	9.2%
Other Services, Except Public Administration	6.2%	6.3%	6.3%	6.4%	6.4%	6.5%	6.6%	6.8%	7.1%	7.4%	8.0%
Federal Civilian Government	2.1%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.1%	2.0%	1.9%	1.7%
Federal Military	5.7%	6.3%	6.3%	6.3%	6.3%	6.2%	6.1%	5.9%	5.5%	5.1%	4.6%
State and Local Government	14.0%	14.3%	13.9%	13.9%	13.8%	13.7%	13.6%	13.3%	12.7%	12.3%	11.3%
Total Earnings (in millions of 2005 dollars)	6,873.26	7,544.84	7,610.27	7,610.52	7,850.34	8,014.26	8,181.56	8,886.17	10,058.07	11,152.07	13,712.63
Farm	0.5%	0.3%	0.3%	0.3%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Forestry, Fishing, Related Activities	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Mining	1.7%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%
Utilities	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%
Construction	7.6%	8.1%	7.5%	7.1%	7.1%	7.0%	7.0%	6.9%	6.8%	6.6%	6.3%
Manufacturing	14.6%	14.0%	14.9%	15.9%	15.5%	15.2%	14.9%	13.8%	12.2%	11.0%	8.8%
Wholesale Trade	2.7%	2.6%	2.5%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%	2.3%	2.2%
Retail Trade	6.3%	5.6%	5.6%	5.5%	5.4%	5.4%	5.4%	5.3%	5.1%	5.0%	4.7%
Transportation and Warehousing	3.6%	3.2%	3.4%	3.5%	3.4%	3.4%	3.4%	3.4%	3.4%	3.3%	3.3%
Information	2.6%	1.0%	0.9%	1.0%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%
Finance and Insurance	2.3%	2.3%	2.3%	2.2%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.0%
Real Estate/Rental and Lease	1.2%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%
Professional and Technical Services	5.4%	5.0%	5.0%	5.0%	5.1%	5.1%	5.2%	5.5%	6.0%	6.4%	7.2%
Management	1.5%	0.6%	0.6%	0.6%	0.9%	0.9%	0.9%	1.0%	1.0%	1.1%	1.2%
Administrative and Waste Services	2.3%	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.7%	2.9%	3.1%	3.5%
Educational Services	0.6%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Health Care and Social Assistance	8.7%	10.6%	10.6%	10.5%	10.6%	10.8%	10.9%	11.7%	12.9%	13.9%	16.1%
Arts, Entertainment, and Recreation	1.5%	0.6%	0.6%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
Accommodation and Food Services	3.7%	3.9%	3.8%	3.8%	3.8%	3.8%	3.8%	3.9%	4.1%	4.2%	4.4%
Other Services, Except Public Administration	3.7%	3.5%	3.5%	3.5%	3.5%	3.6%	3.6%	3.7%	3.9%	4.0%	4.3%
Federal Civilian Government	3.8%	3.9%	3.8%	3.8%	3.7%	3.7%	3.7%	3.7%	3.6%	3.6%	3.5%
Federal Military	10.6%	13.2%	13.6%	13.4%	13.4%	13.4%	13.5%	13.6%	13.7%	13.8%	13.8%
State and Local Government	13.8%	14.3%	13.8%	13.6%	13.4%	13.4%	13.3%	13.2%	13.0%	12.7%	12.2%
Total Personal Income per Capita (in 2005 dollars)	27,227	30,312	30,763	30,470	30,593	30,948	31,371	33,456	37,259	40,991	50,082
Woods & Poole Economics Wealth Index (U.S. = 100)	69.2	80.2	79.9	79.1	79.1	79.4	79.7	80.6	81.9	82.9	84.6
Persons per Household (in number of people)	2.6	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Mean Household Total Personal Income (in 2005 dollars)	71,904	80,936	81,820	80,597	80,477	80,944	81,615	85,962	95,585	105,750	130,964

Table 4-14. Demographic and Employment Baseline Projections for Economic Impact Area LA-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Number of Households (in thousands)	128.17	129.59	130.28	132.19	134.13	136.16	138.15	145.10	153.32	159.07	169.86
Income <$10,000 (thousands of households, 2000$)	12.2%	10.7%	10.5%	10.5%	10.3%	10.2%	10.1%	9.1%	7.6%	6.5%	4.7%
Income $10,000 to $19,999	15.0%	13.0%	12.8%	12.8%	12.6%	12.4%	12.3%	11.1%	9.3%	7.9%	5.8%
Income $20,000 to $29,999	13.2%	11.4%	11.2%	11.2%	11.0%	10.9%	10.7%	9.7%	8.1%	6.9%	5.0%
Income $30,000 to $44,999	19.6%	18.5%	18.2%	18.1%	17.9%	17.7%	17.6%	16.0%	13.5%	11.4%	8.2%
Income $45,000 to $59,999	14.9%	17.4%	17.7%	17.8%	18.0%	18.2%	18.5%	19.8%	20.3%	18.6%	13.6%
Income $60,000 to $74,999	9.5%	11.0%	11.2%	11.3%	11.4%	11.6%	11.8%	13.1%	15.8%	18.6%	20.2%
Income $75,000 to $99,999	8.7%	10.1%	10.3%	10.3%	10.5%	10.6%	10.8%	12.0%	14.4%	17.0%	24.1%
Income $100,000 or more	6.8%	7.9%	8.0%	8.1%	8.2%	8.3%	8.4%	9.3%	11.1%	13.1%	18.3%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-15

Demographic and Employment Baseline Projections for Economic Impact Area LA-2

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	558.42	585.06	588.41	598.63	608.98	619.45	629.98	672.73	738.07	792.83	902.89
Age Under 19 Years	30.0%	29.0%	28.6%	28.5%	28.6%	28.5%	28.5%	28.6%	28.5%	28.1%	26.9%
Age 20 to 34	20.6%	21.1%	21.4%	21.3%	21.1%	21.0%	20.7%	19.5%	18.0%	18.0%	19.0%
Age 35 to 49	21.8%	19.5%	19.1%	18.7%	18.4%	18.2%	18.2%	18.5%	19.7%	19.4%	17.4%
Age 50 to 64	16.1%	18.6%	19.0%	19.3%	19.5%	19.6%	19.6%	19.2%	17.2%	16.4%	18.3%
Age 65 and over	11.5%	11.9%	12.0%	12.2%	12.5%	12.7%	13.0%	14.1%	16.6%	18.1%	18.4%
Median Age of Population (years)	35.0	35.7	35.7	35.8	36.0	36.1	36.2	37.0	38.1	38.9	39.1
White Population (in thousands)	69.3%	67.6%	67.4%	67.2%	67.1%	67.0%	66.8%	66.2%	65.3%	64.5%	62.8%
Black Population (in thousands)	27.1%	27.9%	27.9%	27.9%	28.0%	28.0%	28.0%	28.1%	28.2%	28.3%	28.5%
Native American Population (in thousands)	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Asian and Pacific Islander Population (in thousands)	1.2%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.6%	1.7%	1.9%
Hispanic or Latino Population (in thousands)	2.1%	2.8%	3.0%	3.1%	3.2%	3.3%	3.4%	3.8%	4.4%	5.0%	6.4%
Male Population (in thousands)	48.7%	48.8%	48.8%	48.8%	48.8%	48.8%	48.9%	49.0%	49.1%	49.1%	49.2%
Total Employment (in thousands of jobs)	297.51	325.85	326.83	339.22	344.71	350.28	355.90	379.08	415.91	448.58	519.72
Farm Employment	1.9%	1.9%	1.8%	1.8%	1.7%	1.7%	1.7%	1.6%	1.5%	1.4%	1.2%
Forestry, Fishing, Related Activities	0.6%	0.6%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Mining	6.9%	7.6%	7.6%	7.6%	7.6%	7.5%	7.5%	7.3%	7.0%	6.8%	6.3%
Utilities	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Construction	6.7%	6.3%	6.1%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	5.9%	5.9%
Manufacturing	6.1%	5.9%	6.0%	6.2%	6.2%	6.1%	6.0%	5.7%	5.3%	4.9%	4.3%
Wholesale Trade	3.7%	3.6%	3.7%	3.9%	3.9%	3.8%	3.8%	3.7%	3.6%	3.5%	3.2%
Retail Trade	11.5%	10.8%	10.8%	10.9%	10.9%	10.9%	10.9%	10.9%	10.9%	10.9%	10.8%
Transportation and Warehousing	3.5%	2.9%	2.9%	2.7%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
Information Employment	1.5%	1.2%	1.1%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%
Finance and Insurance	3.4%	3.7%	3.7%	3.5%	3.5%	3.4%	3.4%	3.3%	3.1%	2.9%	2.6%
Real Estate/Rental and Lease	4.0%	4.2%	4.4%	4.3%	4.3%	4.3%	4.3%	4.2%	4.2%	4.1%	4.0%
Professional and Technical Services	4.7%	5.1%	5.2%	5.4%	5.4%	5.4%	5.4%	5.5%	5.6%	5.6%	5.8%
Management	1.1%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Administrative and Waste Services	4.6%	4.8%	4.9%	5.0%	5.0%	5.1%	5.1%	5.2%	5.4%	5.6%	6.0%
Educational Services	1.2%	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Health Care and Social Assistance	11.2%	11.9%	12.0%	11.9%	12.0%	12.1%	12.3%	12.7%	13.5%	14.1%	15.5%

Table 4-15. Demographic and Employment Baseline Projections for Economic Impact Area LA-2 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Arts, Entertainment, and Recreation	1.5%	1.7%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.8%
Accommodation and Food Services	6.4%	6.2%	6.3%	6.4%	6.4%	6.4%	6.4%	6.5%	6.7%	6.8%	7.0%
Other Services, Except Public Administration	7.0%	6.7%	6.6%	6.5%	6.6%	6.6%	6.7%	6.9%	7.2%	7.4%	8.0%
Federal Civilian Government	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%
Federal Military	0.9%	0.9%	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%
State and Local Government	10.8%	10.5%	10.2%	10.1%	10.1%	10.1%	10.0%	9.9%	9.7%	9.6%	9.2%
Total Earnings (in millions of 2005 dollars)	11,484.00	13,494.78	13,752.84	14,349.59	14,682.89	15,067.24	15,460.41	17,124.71	19,916.17	22,539.61	28,709.70
Farm	0.8%	1.1%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.0%	1.0%	0.8%
Forestry, Fishing, Related Activities	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	13.7%	13.4%	13.7%	13.9%	13.6%	13.6%	13.6%	13.5%	13.4%	13.2%	12.9%
Utilities	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%
Construction	7.1%	7.2%	6.9%	6.7%	6.6%	6.6%	6.5%	6.3%	6.0%	5.8%	5.3%
Manufacturing	7.5%	7.8%	8.0%	8.2%	8.5%	8.5%	8.4%	8.2%	7.9%	7.7%	7.1%
Wholesale Trade	4.7%	4.7%	5.0%	5.3%	5.2%	5.2%	5.2%	5.1%	4.9%	4.8%	4.6%
Retail Trade	7.9%	7.0%	6.9%	6.9%	6.9%	6.8%	6.8%	6.5%	6.1%	5.8%	5.2%
Transportation and Warehousing	4.6%	4.1%	4.1%	4.0%	3.8%	3.8%	3.7%	3.7%	3.6%	3.6%	3.4%
Information	1.7%	1.2%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%	1.4%
Finance and Insurance	4.1%	2.8%	2.9%	2.6%	2.7%	2.6%	2.6%	2.5%	2.4%	2.3%	2.0%
Real Estate/Rental and Lease	3.5%	3.6%	3.8%	3.7%	3.7%	3.7%	3.7%	3.6%	3.5%	3.4%	3.2%
Professional and Technical Services	6.0%	6.7%	6.9%	7.2%	7.3%	7.3%	7.4%	7.6%	7.9%	8.2%	8.8%
Management	1.6%	1.8%	1.8%	1.8%	1.9%	1.9%	1.9%	2.0%	2.1%	2.2%	2.4%
Administrative and Waste Services	3.1%	3.3%	3.2%	3.1%	3.1%	3.2%	3.2%	3.3%	3.5%	3.6%	3.9%
Educational Services	0.7%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%
Health Care and Social Assistance	11.3%	12.5%	12.5%	12.4%	12.6%	12.7%	12.9%	13.4%	14.2%	14.9%	16.4%
Arts, Entertainment, and Recreation	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Accommodation and Food Services	2.5%	2.7%	2.8%	2.9%	2.9%	2.9%	2.9%	3.0%	3.1%	3.1%	3.2%
Other Services, Except Public Administration	4.5%	4.5%	4.4%	4.3%	4.3%	4.4%	4.4%	4.5%	4.6%	4.8%	5.1%
Federal Civilian Government	1.2%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Federal Military	0.9%	0.9%	0.9%	0.9%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
State and Local Government	11.3%	11.6%	11.0%	10.7%	10.7%	10.7%	10.7%	10.7%	10.6%	10.5%	10.4%
Total Personal Income per Capita (in 2005 dollars)	28,507	32,772	33,321	33,752	33,768	34,047	34,402	36,219	39,557	42,806	50,543
Woods & Poole Economics Wealth Index (U.S. = 100)	72.9	82.8	81.9	81.5	81.1	81.1	81.0	80.7	80.2	79.7	78.7
Persons per Household (in number of people)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5

Table 4-15. Demographic and Employment Baseline Projections for Economic Impact Area LA-2 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	74,766	86,052	87,168	87,764	87,280	87,455	87,855	91,179	99,160	107,670	128,326
Number of Households (in thousands)	212.92	222.81	224.93	230.22	235.61	241.16	246.69	267.23	294.43	315.20	355.62
Income <$10,000 (thousands of households, 2000$)	15.8%	13.6%	13.4%	13.2%	13.0%	12.8%	12.5%	11.7%	9.7%	8.3%	6.0%
Income $10,000 to $19,999	15.2%	13.2%	12.9%	12.7%	12.5%	12.3%	12.2%	11.4%	9.5%	8.2%	6.0%
Income $20,000 to $29,999	13.0%	11.4%	11.1%	10.9%	10.8%	10.7%	10.5%	9.8%	8.3%	7.1%	5.2%
Income $30,000 to $44,999	18.3%	18.2%	18.0%	17.7%	17.6%	17.5%	17.4%	16.8%	14.6%	12.6%	9.1%
Income $45,000 to $59,999	14.0%	16.2%	16.4%	16.6%	16.8%	16.9%	17.1%	17.9%	18.8%	18.6%	15.2%
Income $60,000 to $74,999	9.1%	10.6%	10.8%	11.0%	11.2%	11.4%	11.5%	12.4%	14.8%	17.0%	19.5%
Income $75,000 to $99,999	7.4%	8.7%	8.9%	9.1%	9.2%	9.4%	9.5%	10.2%	12.3%	14.4%	19.9%
Income $100,000 or more	7.1%	8.2%	8.5%	8.7%	8.8%	9.0%	9.1%	9.8%	11.9%	13.8%	19.2%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-16

Demographic and Employment Baseline Projections for Economic Impact Area LA-3

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	1,051.06	1,142.41	1,147.53	1,158.87	1,170.43	1,182.18	1,194.01	1,242.03	1,315.00	1,375.33	1,494.59
Age Under 19 Years	29.6%	28.3%	28.0%	27.9%	27.8%	27.8%	27.8%	28.0%	28.1%	27.8%	26.9%
Age 20 to 34	22.3%	22.8%	22.9%	22.9%	22.8%	22.6%	22.3%	20.8%	19.2%	19.1%	20.4%
Age 35 to 49	21.5%	19.6%	19.2%	18.9%	18.6%	18.5%	18.4%	18.9%	19.9%	19.7%	17.3%
Age 50 to 64	16.4%	18.3%	18.6%	18.7%	18.8%	18.9%	18.9%	18.4%	16.8%	16.1%	17.9%
Age 65 and over	10.3%	11.0%	11.3%	11.6%	11.9%	12.2%	12.5%	13.9%	16.1%	17.3%	17.5%
Median Age of Population (years)	34.6	35.7	35.8	35.9	36.1	36.2	36.4	37.2	38.4	39.2	39.6
White Population (in thousands)	65.3%	62.4%	62.2%	61.9%	61.7%	61.4%	61.2%	60.1%	58.6%	57.2%	54.5%
Black Population (in thousands)	29.4%	31.1%	31.1%	31.2%	31.3%	31.4%	31.5%	31.9%	32.4%	32.7%	33.2%
Native American Population (in thousands)	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%
Asian and Pacific Islander Population (in thousands)	1.5%	1.7%	1.7%	1.8%	1.8%	1.8%	1.9%	2.0%	2.1%	2.3%	2.6%
Hispanic or Latino Population (in thousands)	2.6%	3.7%	3.9%	4.0%	4.1%	4.2%	4.4%	4.9%	5.7%	6.6%	8.5%
Male Population (in thousands)	48.7%	48.9%	48.8%	48.8%	48.8%	48.8%	48.9%	48.9%	48.9%	48.9%	49.0%
Total Employment (in thousands of jobs)	606.81	669.39	667.49	674.34	684.23	694.25	704.39	746.15	812.61	871.69	1,000.90
Farm Employment	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.5%	0.4%
Forestry, Fishing, Related Activities	0.7%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Mining	1.5%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.7%	1.6%	1.5%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%
Construction	9.8%	9.0%	8.9%	8.9%	8.8%	8.7%	8.7%	8.5%	8.1%	7.8%	7.2%
Manufacturing	6.8%	6.3%	6.4%	6.5%	6.4%	6.3%	6.2%	5.8%	5.2%	4.8%	4.0%
Wholesale Trade	3.2%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.8%	2.7%	2.6%	2.4%
Retail Trade	10.9%	10.3%	10.4%	10.5%	10.5%	10.5%	10.4%	10.3%	10.0%	9.8%	9.2%
Transportation and Warehousing	4.4%	4.4%	4.4%	4.5%	4.5%	4.5%	4.5%	4.5%	4.6%	4.6%	4.7%
Information Employment	1.4%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%
Finance and Insurance	3.5%	4.0%	4.1%	3.9%	3.8%	3.8%	3.8%	3.7%	3.6%	3.5%	3.3%
Real Estate/Rental and Lease	3.6%	4.1%	4.2%	4.1%	4.1%	4.1%	4.1%	4.1%	4.0%	4.0%	3.9%
Professional and Technical Services	4.8%	5.1%	5.1%	5.2%	5.2%	5.3%	5.3%	5.4%	5.6%	5.7%	5.9%
Management	1.0%	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%
Administrative and Waste Services	5.8%	6.1%	6.0%	5.7%	5.8%	5.8%	5.9%	6.1%	6.4%	6.6%	7.1%
Educational Services	1.1%	1.3%	1.4%	1.5%	1.5%	1.6%	1.6%	1.7%	1.8%	2.0%	2.3%
Health Care and Social Assistance	8.8%	9.8%	10.0%	10.0%	10.1%	10.3%	10.4%	10.9%	11.7%	12.4%	13.8%

Table 4-16. Demographic and Employment Baseline Projections for Economic Impact Area LA-3 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Arts, Entertainment, and Recreation	1.3%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.7%	1.8%	1.8%	1.9%
Accommodation and Food Services	6.6%	6.3%	6.5%	6.6%	6.6%	6.6%	6.7%	6.8%	7.0%	7.2%	7.5%
Other Services, Except Public Administration	6.7%	6.8%	6.8%	6.8%	6.9%	7.0%	7.0%	7.4%	7.9%	8.3%	9.2%
Federal Civilian Government	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.5%	0.5%
Federal Military	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.7%	0.7%	0.6%
State and Local Government	15.6%	14.6%	14.1%	13.9%	13.9%	13.8%	13.7%	13.3%	12.8%	12.3%	11.4%
Total Earnings (in millions of 2005 dollars)	24,055.56	28,740.68	29,009.30	29,302.09	29,854.78	30,546.72	31,253.42	34,234.30	39,202.81	43,846.48	54,710.37
Farm	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Forestry, Fishing, Related Activities	0.3%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	2.6%	2.9%	2.9%	3.0%	3.0%	3.0%	3.0%	2.9%	2.9%	2.8%	2.7%
Utilities	0.7%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Construction	10.3%	11.0%	10.8%	10.7%	10.4%	10.3%	10.2%	9.7%	9.0%	8.4%	7.3%
Manufacturing	12.4%	11.3%	11.5%	11.8%	11.9%	11.8%	11.6%	11.1%	10.4%	9.8%	8.5%
Wholesale Trade	4.4%	4.0%	4.1%	4.2%	4.2%	4.2%	4.2%	4.2%	4.1%	4.0%	3.8%
Retail Trade	7.2%	6.3%	6.3%	6.4%	6.3%	6.3%	6.2%	5.9%	5.4%	5.1%	4.4%
Transportation and Warehousing	6.0%	7.1%	7.3%	7.5%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.5%
Information	1.7%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%
Finance and Insurance	4.3%	4.2%	4.4%	4.1%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%	3.7%
Real Estate/Rental and Lease	2.1%	2.2%	2.3%	2.2%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%	1.9%
Professional and Technical Services	6.0%	6.4%	6.4%	6.4%	6.5%	6.5%	6.6%	6.9%	7.3%	7.7%	8.4%
Management	1.4%	1.8%	2.0%	2.1%	2.1%	2.1%	2.2%	2.3%	2.6%	2.8%	3.2%
Administrative and Waste Services	3.5%	4.0%	3.7%	3.5%	3.6%	3.7%	3.7%	3.9%	4.3%	4.6%	5.2%
Educational Services	0.6%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%	0.9%	1.0%	1.1%	1.3%
Health Care and Social Assistance	9.2%	9.4%	9.6%	9.6%	9.8%	9.9%	10.0%	10.6%	11.5%	12.3%	13.9%
Arts, Entertainment, and Recreation	0.7%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.6%	0.6%	0.6%	0.6%
Accommodation and Food Services	2.7%	2.6%	2.7%	2.7%	2.8%	2.8%	2.8%	2.9%	3.0%	3.1%	3.2%
Other Services, Except Public Administration	4.1%	3.9%	3.9%	3.9%	3.9%	4.0%	4.0%	4.2%	4.4%	4.6%	5.1%
Federal Civilian Government	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.0%
Federal Military	0.9%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
State and Local Government	17.5%	17.1%	16.4%	16.2%	16.3%	16.3%	16.2%	16.1%	15.9%	15.6%	15.1%
Total Personal Income per Capita (in 2005 dollars)	30,406	33,467	33,978	33,975	34,080	34,410	34,810	36,797	40,422	43,957	52,429
Woods & Poole Economics Wealth Index (U.S. = 100)	78.2	87.9	87.2	87.0	87.2	87.3	87.5	87.9	88.2	88.4	88.4
Persons per Household (in number of people)	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Mean Household Total Personal Income (in 2005 dollars)	81,039	89,653	90,645	90,103	89,862	90,187	90,726	94,626	103,650	113,236	136,682

Table 4-16. Demographic and Employment Baseline Projections for Economic Impact Area LA-3 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Number of Households (in thousands)	394.36	426.46	430.14	436.98	443.89	451.05	458.12	482.99	512.84	533.89	573.30
Income <$10,000 (thousands of households, 2000$)	12.5%	11.1%	10.9%	10.8%	10.7%	10.5%	10.4%	9.6%	8.1%	7.1%	5.2%
Income $10,000 to $19,999	13.3%	11.9%	11.7%	11.6%	11.5%	11.3%	11.1%	10.3%	8.7%	7.6%	5.5%
Income $20,000 to $29,999	12.2%	10.9%	10.7%	10.6%	10.5%	10.4%	10.2%	9.4%	8.0%	7.0%	5.1%
Income $30,000 to $44,999	17.6%	16.3%	16.1%	16.1%	15.9%	15.8%	15.6%	14.5%	12.4%	10.8%	7.9%
Income $45,000 to $59,999	14.6%	16.2%	16.4%	16.5%	16.6%	16.8%	16.9%	17.4%	17.2%	15.7%	11.7%
Income $60,000 to $74,999	11.0%	12.5%	12.7%	12.8%	12.9%	13.1%	13.3%	14.5%	17.1%	19.1%	19.5%
Income $75,000 to $99,999	9.9%	11.1%	11.3%	11.4%	11.5%	11.7%	11.9%	12.9%	15.2%	17.6%	24.4%
Income $100,000 or more	9.0%	10.0%	10.1%	10.2%	10.3%	10.4%	10.6%	11.4%	13.3%	15.2%	20.8%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-17

Demographic and Employment Baseline Projections for Economic Impact Area LA-4

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	1,431.31	1,242.69	1,260.01	1,265.95	1,272.16	1,278.59	1,285.13	1,312.22	1,354.31	1,389.22	1,458.44
Age Under 19 Years	28.0%	26.1%	25.8%	25.8%	25.8%	25.8%	25.8%	26.0%	26.0%	25.7%	24.8%
Age 20 to 34	20.6%	21.3%	21.5%	21.4%	21.2%	21.0%	20.6%	19.0%	17.1%	17.1%	18.3%
Age 35 to 49	22.2%	20.1%	19.6%	19.3%	19.2%	19.0%	19.0%	19.7%	20.8%	20.3%	17.4%
Age 50 to 64	17.9%	20.3%	20.6%	20.7%	20.7%	20.8%	20.8%	20.0%	18.1%	17.5%	19.8%
Age 65 and over	11.4%	12.3%	12.5%	12.8%	13.1%	13.5%	13.8%	15.3%	17.9%	19.3%	19.7%
Median Age of Population (years)	36.0	36.7	36.8	36.9	37.0	37.1	37.2	37.8	39.0	39.6	39.7
White Population (in thousands)	53.7%	54.8%	54.5%	54.3%	54.1%	54.0%	53.8%	53.1%	52.1%	51.3%	49.5%
Black Population (in thousands)	38.1%	34.5%	34.6%	34.6%	34.5%	34.4%	34.4%	34.1%	33.7%	33.3%	32.4%
Native American Population (in thousands)	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%
Asian and Pacific Islander Population (in thousands)	2.4%	2.8%	2.8%	2.8%	2.9%	2.9%	3.0%	3.1%	3.3%	3.5%	3.7%
Hispanic or Latino Population (in thousands)	5.4%	7.6%	7.7%	7.8%	8.0%	8.2%	8.4%	9.2%	10.3%	11.4%	13.9%
Male Population (in thousands)	48.1%	48.7%	48.7%	48.7%	48.7%	48.8%	48.8%	48.9%	49.0%	49.0%	49.1%
Total Employment (in thousands of jobs)	740.50	744.81	745.46	749.69	756.58	763.49	770.43	798.52	841.58	878.38	954.71
Farm Employment	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%
Mining	1.3%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%	1.2%	1.1%	1.1%	1.0%
Utilities	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.2%
Construction	6.2%	6.7%	6.6%	6.7%	6.6%	6.6%	6.6%	6.5%	6.4%	6.3%	6.1%
Manufacturing	5.6%	5.0%	4.9%	4.9%	4.8%	4.7%	4.6%	4.2%	3.6%	3.2%	2.5%
Wholesale Trade	3.6%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.2%	3.2%	3.2%	3.2%
Retail Trade	10.0%	9.6%	9.4%	9.4%	9.4%	9.4%	9.4%	9.3%	9.2%	9.2%	9.0%
Transportation and Warehousing	4.1%	4.0%	4.1%	4.2%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.0%
Information Employment	1.6%	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Finance and Insurance	3.9%	4.3%	4.4%	4.1%	4.1%	4.0%	4.0%	3.9%	3.7%	3.5%	3.2%
Real Estate/Rental and Lease	4.0%	4.3%	4.4%	4.2%	4.2%	4.2%	4.2%	4.3%	4.3%	4.4%	4.5%
Professional and Technical Services	5.7%	6.5%	6.5%	6.7%	6.7%	6.8%	6.8%	7.0%	7.2%	7.4%	7.8%
Management	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Administrative and Waste Services	6.4%	6.7%	6.9%	6.9%	7.0%	7.0%	7.1%	7.4%	7.8%	8.1%	8.8%
Educational Services	3.1%	3.2%	3.3%	3.3%	3.4%	3.4%	3.4%	3.5%	3.6%	3.7%	3.9%

Table 4-17. Demographic and Employment Baseline Projections for Economic Impact Area LA-4 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	8.8%	9.3%	9.4%	9.4%	9.4%	9.4%	9.4%	9.4%	9.5%	9.4%	9.4%
Arts, Entertainment, and Recreation	2.5%	2.5%	2.5%	2.4%	2.5%	2.5%	2.5%	2.6%	2.7%	2.8%	3.1%
Accommodation and Food Services	8.8%	8.9%	9.3%	9.7%	9.7%	9.8%	9.8%	10.0%	10.3%	10.5%	10.9%
Other Services, Except Public Administration	6.5%	6.7%	6.7%	6.6%	6.7%	6.8%	6.8%	7.1%	7.5%	7.8%	8.4%
Federal Civilian Government	2.1%	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.4%
Federal Military	1.4%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.0%	0.9%
State and Local Government	11.9%	11.1%	10.6%	10.4%	10.3%	10.3%	10.2%	9.9%	9.5%	9.1%	8.4%
Total Earnings (in millions of 2005 dollars)	33,666.07	34,271.00	34,751.75	35,008.67	35,826.56	36,464.52	37,112.26	39,803.97	44,161.53	48,109.85	56,971.53
Farm	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Forestry, Fishing, Related Activities	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Mining	4.4%	3.0%	3.1%	3.1%	3.1%	3.1%	3.0%	2.9%	2.8%	2.6%	2.4%
Utilities	1.2%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%	0.8%	0.7%
Construction	6.5%	7.1%	7.1%	7.2%	7.2%	7.2%	7.1%	6.9%	6.5%	6.2%	5.5%
Manufacturing	8.6%	8.9%	8.8%	8.7%	8.4%	8.3%	8.2%	7.6%	6.9%	6.3%	5.2%
Wholesale Trade	5.3%	5.1%	5.2%	5.2%	5.2%	5.2%	5.2%	5.3%	5.4%	5.5%	5.6%
Retail Trade	6.2%	5.8%	5.8%	5.7%	5.6%	5.6%	5.5%	5.3%	5.0%	4.8%	4.3%
Transportation and Warehousing	5.1%	5.3%	5.5%	5.5%	5.4%	5.4%	5.3%	5.2%	5.0%	4.8%	4.5%
Information	1.7%	1.4%	1.5%	1.6%	1.6%	1.6%	1.7%	1.7%	1.7%	1.8%	1.9%
Finance and Insurance	5.1%	4.5%	4.6%	4.3%	4.4%	4.4%	4.3%	4.2%	4.1%	3.9%	3.6%
Real Estate/Rental and Lease	2.6%	1.4%	1.4%	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%
Professional and Technical Services	8.0%	9.5%	9.8%	10.3%	10.4%	10.5%	10.6%	11.1%	11.8%	12.3%	13.5%
Management	1.8%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%	2.0%	2.1%	2.2%	2.4%
Administrative and Waste Services	4.0%	4.4%	4.5%	4.5%	4.5%	4.6%	4.6%	4.9%	5.3%	5.6%	6.3%
Educational Services	2.2%	2.5%	2.6%	2.7%	2.7%	2.7%	2.7%	2.8%	3.0%	3.2%	3.4%
Health Care and Social Assistance	8.7%	9.5%	9.4%	9.2%	9.2%	9.2%	9.3%	9.4%	9.5%	9.6%	9.7%
Arts, Entertainment, and Recreation	2.1%	1.7%	1.8%	1.8%	1.9%	1.9%	1.9%	2.0%	2.1%	2.2%	2.4%
Accommodation and Food Services	4.4%	4.8%	4.9%	5.0%	5.0%	5.1%	5.1%	5.2%	5.4%	5.5%	5.8%
Other Services, Except Public Administration	3.7%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	4.0%	4.2%	4.3%	4.7%
Federal Civilian Government	4.2%	3.7%	3.6%	3.5%	3.5%	3.5%	3.5%	3.5%	3.6%	3.6%	3.7%
Federal Military	1.8%	1.7%	1.7%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.7%	1.8%
State and Local Government	12.1%	12.7%	12.3%	12.1%	12.0%	12.0%	12.0%	11.8%	11.6%	11.5%	11.1%
Total Personal Income per Capita (in 2005 dollars)	31,461	37,558	38,141	38,473	38,887	39,232	39,672	41,926	46,044	50,030	59,481
Woods & Poole Economics Wealth Index (U.S. = 100)	77.3	93.0	92.3	92.6	92.3	92.3	92.4	92.3	92.0	91.6	90.4
Persons per Household (in number of people)	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table 4-17. Demographic and Employment Baseline Projections for Economic Impact Area LA-4 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	84,130	96,574	97,610	97,943	98,476	98,800	99,398	103,829	113,973	124,630	150,391
Number of Households (in thousands)	535.25	483.28	492.35	497.27	502.36	507.71	512.92	529.88	547.13	557.67	576.83
Income <$10,000 (thousands of households, 2000$)	12.9%	10.7%	10.5%	10.3%	10.2%	10.0%	9.9%	9.1%	7.7%	6.7%	5.0%
Income $10,000 to $19,999	13.7%	11.6%	11.4%	11.2%	11.0%	10.9%	10.8%	9.9%	8.5%	7.5%	5.6%
Income $20,000 to $29,999	13.0%	11.1%	10.9%	10.8%	10.6%	10.5%	10.4%	9.6%	8.3%	7.3%	5.5%
Income $30,000 to $44,999	17.6%	15.1%	14.9%	14.8%	14.6%	14.5%	14.4%	13.5%	11.7%	10.4%	7.9%
Income $45,000 to $59,999	13.6%	15.3%	15.4%	15.6%	15.6%	15.7%	15.7%	15.7%	14.8%	13.5%	10.4%
Income $60,000 to $74,999	10.0%	11.9%	12.1%	12.2%	12.4%	12.6%	12.7%	13.8%	15.7%	16.5%	15.0%
Income $75,000 to $99,999	9.2%	11.4%	11.5%	11.7%	11.9%	12.0%	12.2%	13.2%	15.6%	17.8%	23.1%
Income $100,000 or more	10.1%	13.1%	13.3%	13.5%	13.7%	13.9%	14.0%	15.2%	17.9%	20.4%	27.4%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-18

Demographic and Employment Baseline Projections for Economic Impact Area MS-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	483.49	482.30	486.36	489.21	492.17	495.21	498.29	510.96	530.49	546.67	578.72
Age Under 19 Years	28.4%	27.7%	27.4%	27.3%	27.2%	27.3%	27.3%	27.6%	27.6%	27.1%	26.4%
Age 20 to 34	19.8%	19.9%	20.1%	20.1%	20.0%	19.8%	19.6%	18.6%	17.7%	17.7%	18.8%
Age 35 to 49	22.0%	20.3%	19.9%	19.6%	19.3%	19.0%	18.9%	19.0%	19.1%	18.9%	17.5%
Age 50 to 64	17.8%	19.4%	19.7%	19.8%	19.9%	20.0%	20.1%	19.7%	18.4%	17.5%	18.1%
Age 65 and over	12.0%	12.7%	12.9%	13.2%	13.6%	13.8%	14.1%	15.2%	17.3%	18.8%	19.2%
Median Age of Population (years)	36.4	37.4	37.5	37.7	37.8	37.9	38.0	38.4	39.0	39.5	39.6
White Population (in thousands)	75.8%	73.9%	73.2%	73.0%	72.8%	72.7%	72.5%	71.7%	70.6%	69.6%	67.7%
Black Population (in thousands)	18.7%	19.3%	19.8%	19.9%	19.9%	20.0%	20.1%	20.3%	20.8%	21.1%	21.7%
Native American Population (in thousands)	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%
Asian and Pacific Islander Population (in thousands)	2.0%	2.1%	2.1%	2.1%	2.1%	2.2%	2.2%	2.2%	2.3%	2.3%	2.3%
Hispanic or Latino Population (in thousands)	3.0%	4.2%	4.4%	4.5%	4.6%	4.7%	4.8%	5.2%	5.9%	6.5%	7.9%
Male Population (in thousands)	49.7%	49.9%	49.9%	49.9%	49.9%	49.8%	49.8%	49.8%	49.8%	49.8%	49.7%
Total Employment (in thousands of jobs)	238.83	240.12	242.03	244.21	246.33	248.45	250.60	259.29	272.69	284.28	308.79
Farm Employment	1.4%	1.4%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%
Forestry, Fishing, Related Activities	0.8%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%
Mining	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Utilities	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%
Construction	7.5%	8.1%	8.0%	8.4%	8.4%	8.4%	8.4%	8.4%	8.5%	8.5%	8.4%
Manufacturing	9.5%	9.5%	9.3%	9.3%	9.2%	9.0%	8.9%	8.2%	7.4%	6.7%	5.5%
Wholesale Trade	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%
Retail Trade	10.9%	10.3%	10.4%	10.4%	10.4%	10.4%	10.4%	10.3%	10.1%	9.9%	9.4%
Transportation and Warehousing	2.4%	2.3%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.3%	2.3%	2.4%
Information Employment	1.4%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%
Finance and Insurance	2.5%	2.9%	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	2.8%	2.8%	2.7%
Real Estate/Rental and Lease	3.1%	3.3%	3.4%	3.3%	3.3%	3.3%	3.4%	3.4%	3.5%	3.6%	3.8%
Professional and Technical Services	3.8%	4.1%	4.0%	3.9%	4.0%	4.0%	4.0%	4.0%	4.1%	4.2%	4.3%
Management	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%
Administrative and Waste Services	5.4%	6.6%	6.8%	6.9%	7.0%	7.2%	7.3%	8.0%	9.1%	10.1%	12.3%
Educational Services	0.5%	0.7%	0.8%	0.9%	0.9%	1.0%	1.0%	1.1%	1.2%	1.4%	1.7%

Table 4-18. Demographic and Employment Baseline Projections for Economic Impact Area MS-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	6.2%	6.4%	6.3%	6.1%	6.2%	6.2%	6.3%	6.4%	6.7%	6.8%	7.1%
Arts, Entertainment, and Recreation	2.2%	2.2%	2.1%	2.1%	2.1%	2.1%	2.1%	2.2%	2.2%	2.3%	2.4%
Accommodation and Food Services	12.1%	10.4%	10.7%	10.7%	10.6%	10.6%	10.6%	10.4%	10.2%	9.9%	9.4%
Other Services, Except Public Administration	5.5%	5.0%	4.9%	4.9%	4.9%	4.9%	4.9%	5.0%	5.2%	5.3%	5.4%
Federal Civilian Government	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%	3.8%	3.7%	3.5%	3.4%	3.1%
Federal Military	5.7%	5.5%	5.5%	5.3%	5.3%	5.3%	5.2%	5.1%	4.9%	4.7%	4.3%
State and Local Government	12.3%	13.0%	12.9%	12.9%	12.9%	12.9%	12.9%	12.8%	12.7%	12.5%	12.2%
Total Earnings (in millions of 2005 dollars)	9,318.99	9,982.21	9,882.08	10,040.86	10,210.79	10,389.92	10,571.81	11,327.83	12,553.09	13,665.84	16,177.84
Farm	0.3%	0.0%	0.0%	0.0%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
Forestry, Fishing, Related Activities	0.5%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%
Mining	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Utilities	2.1%	1.7%	1.7%	1.7%	1.8%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%
Construction	6.0%	7.6%	7.6%	8.0%	8.0%	7.9%	7.9%	7.7%	7.4%	7.2%	6.7%
Manufacturing	15.4%	16.5%	16.4%	16.5%	16.2%	16.0%	15.8%	15.0%	13.8%	12.8%	10.9%
Wholesale Trade	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Retail Trade	7.0%	6.3%	6.3%	6.2%	6.1%	6.1%	6.0%	5.7%	5.3%	5.0%	4.4%
Transportation and Warehousing	2.3%	2.2%	2.3%	2.4%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Information	1.4%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%
Finance and Insurance	2.2%	2.4%	2.4%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%
Real Estate/Rental and Lease	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%
Professional and Technical Services	4.6%	5.1%	5.0%	5.0%	5.0%	5.0%	5.1%	5.2%	5.5%	5.6%	6.0%
Management	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%	0.9%
Administrative and Waste Services	3.1%	4.0%	4.1%	4.2%	4.4%	4.5%	4.6%	5.1%	5.9%	6.7%	8.5%
Educational Services	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	0.6%	0.7%	0.8%	0.9%	1.2%
Health Care and Social Assistance	6.7%	6.7%	6.7%	6.7%	6.7%	6.8%	6.8%	7.0%	7.4%	7.6%	8.1%
Arts, Entertainment, and Recreation	1.5%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%
Accommodation and Food Services	8.0%	6.1%	6.4%	6.4%	6.4%	6.4%	6.4%	6.3%	6.2%	6.0%	5.7%
Other Services, Except Public Administration	3.3%	3.2%	3.2%	3.1%	3.1%	3.2%	3.2%	3.2%	3.3%	3.3%	3.4%
Federal Civilian Government	8.4%	7.9%	8.0%	7.9%	7.9%	7.9%	7.9%	7.9%	8.0%	7.9%	7.9%
Federal Military	10.2%	10.0%	9.8%	9.2%	9.3%	9.4%	9.4%	9.5%	9.7%	9.8%	10.1%
State and Local Government	13.2%	14.4%	14.2%	14.0%	14.0%	14.1%	14.1%	14.2%	14.3%	14.4%	14.4%
Total Personal Income per Capita (in 2005 dollars)	27,436	29,962	29,903	29,997	30,093	30,348	30,672	32,334	35,391	38,370	45,492
Woods & Poole Economics Wealth Index (U.S. = 100)	67.8	74.7	73.7	73.5	73.5	73.6	73.6	73.6	73.3	73.1	72.4
Persons per Household (in number of people)	2.6	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7

Table 4-18. Demographic and Employment Baseline Projections for Economic Impact Area MS-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	72,253	79,963	79,462	79,331	79,207	79,477	79,955	83,484	91,624	100,243	121,307
Number of Households (in thousands)	183.59	180.72	183.02	184.98	186.99	189.10	191.15	197.90	204.91	209.25	217.03
Income <$10,000 (thousands of households, 2000$)	10.9%	9.6%	9.5%	9.3%	9.2%	9.1%	8.9%	8.2%	6.9%	5.9%	4.2%
Income $10,000 to $19,999	13.3%	11.7%	11.6%	11.4%	11.2%	11.1%	10.9%	10.0%	8.4%	7.2%	5.1%
Income $20,000 to $29,999	13.9%	12.1%	12.0%	11.8%	11.6%	11.4%	11.3%	10.3%	8.6%	7.4%	5.2%
Income $30,000 to $44,999	20.5%	18.9%	18.8%	18.6%	18.4%	18.2%	17.9%	16.5%	13.9%	11.8%	8.4%
Income $45,000 to $59,999	15.7%	17.9%	18.1%	18.4%	18.6%	18.8%	19.0%	20.0%	20.3%	18.7%	13.7%
Income $60,000 to $74,999	10.2%	11.9%	12.0%	12.2%	12.4%	12.6%	12.7%	13.9%	16.8%	19.4%	20.9%
Income $75,000 to $99,999	8.5%	9.9%	10.0%	10.1%	10.3%	10.4%	10.6%	11.6%	14.0%	16.4%	23.6%
Income $100,000 or more	6.9%	8.0%	8.1%	8.2%	8.3%	8.5%	8.6%	9.4%	11.3%	13.3%	19.1%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-19

Demographic and Employment Baseline Projections for Economic Impact Area TX-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	1,643.97	1,799.29	1,827.28	1,858.83	1,890.78	1,923.07	1,955.52	2,086.93	2,286.87	2,453.62	2,786.67
Age Under 19 Years	35.4%	34.9%	34.7%	34.5%	34.3%	34.2%	34.1%	33.7%	32.6%	32.2%	31.1%
Age 20 to 34	21.4%	20.5%	20.6%	20.5%	20.5%	20.4%	20.3%	20.0%	20.4%	20.1%	20.1%
Age 35 to 49	18.9%	18.7%	18.5%	18.5%	18.4%	18.2%	18.1%	17.9%	17.0%	16.8%	17.0%
Age 50 to 64	13.7%	15.1%	15.1%	15.2%	15.3%	15.4%	15.4%	15.3%	15.4%	15.2%	14.6%
Age 65 and over	10.6%	10.9%	11.1%	11.3%	11.5%	11.8%	12.0%	13.0%	14.7%	15.7%	17.3%
Median Age of Population (years)	33.8	35.7	35.4	35.5	35.6	35.8	35.9	36.4	37.0	37.5	37.8
White Population (in thousands)	18.2%	16.1%	15.8%	15.6%	15.3%	15.1%	14.8%	13.9%	12.7%	11.7%	10.0%
Black Population (in thousands)	1.2%	1.2%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Native American Population (in thousands)	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Asian and Pacific Islander Population (in thousands)	0.9%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
Hispanic or Latino Population (in thousands)	79.5%	81.6%	81.7%	82.0%	82.2%	82.5%	82.7%	83.6%	84.9%	85.9%	87.7%
Male Population (in thousands)	48.8%	48.8%	48.9%	48.9%	48.9%	48.9%	48.8%	48.8%	48.7%	48.6%	48.4%
Total Employment (in thousands of jobs)	728.92	805.32	819.02	833.79	848.38	863.18	878.21	940.55	1,041.20	1,132.22	1,336.29
Farm Employment	1.7%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%	1.2%	1.1%	0.8%
Forestry, Fishing, Related Activities	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	0.9%	0.9%
Mining	1.8%	2.1%	2.1%	2.1%	2.1%	2.1%	2.0%	1.9%	1.8%	1.7%	1.5%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Construction	7.2%	6.3%	6.0%	6.3%	6.2%	6.2%	6.1%	6.0%	5.7%	5.5%	5.0%
Manufacturing	4.0%	3.2%	3.1%	3.1%	3.0%	3.0%	2.9%	2.7%	2.5%	2.2%	1.8%
Wholesale Trade	2.8%	2.6%	2.6%	2.7%	2.7%	2.6%	2.6%	2.5%	2.4%	2.3%	2.1%
Retail Trade	12.0%	11.6%	11.6%	11.7%	11.7%	11.7%	11.7%	11.7%	11.6%	11.6%	11.4%
Transportation and Warehousing	3.3%	3.3%	3.4%	3.6%	3.6%	3.6%	3.6%	3.6%	3.7%	3.7%	3.8%
Information Employment	1.2%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%
Finance and Insurance	3.1%	3.9%	4.0%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	4.0%	4.0%
Real Estate/Rental and Lease	3.0%	3.0%	2.9%	2.8%	2.8%	2.8%	2.8%	2.7%	2.6%	2.6%	2.4%
Professional and Technical Services	3.3%	3.3%	3.3%	3.4%	3.4%	3.5%	3.5%	3.6%	3.7%	3.8%	3.9%
Management	0.2%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.6%
Administrative and Waste Services	5.4%	5.6%	5.7%	5.7%	5.8%	5.8%	5.8%	6.0%	6.2%	6.4%	6.8%
Educational Services	0.9%	1.0%	1.1%	1.1%	1.2%	1.2%	1.2%	1.2%	1.3%	1.4%	1.6%

Table 4-19. Demographic and Employment Baseline Projections for Economic Impact Area TX-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	15.6%	17.4%	17.7%	17.5%	17.7%	17.9%	18.1%	18.9%	20.1%	21.1%	23.1%
Arts, Entertainment, and Recreation	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
Accommodation and Food Services	7.2%	7.4%	7.6%	7.8%	7.8%	7.8%	7.9%	8.0%	8.1%	8.3%	8.4%
Other Services, Except Public Administration	6.5%	6.0%	5.9%	5.8%	5.8%	5.8%	5.8%	5.9%	6.0%	6.0%	6.2%
Federal Civilian Government	1.7%	2.0%	2.0%	2.0%	1.9%	1.9%	1.9%	1.8%	1.7%	1.6%	1.4%
Federal Military	1.3%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.8%	0.8%	0.6%
State and Local Government	15.1%	15.0%	14.6%	14.1%	14.1%	14.0%	13.9%	13.5%	13.0%	12.5%	11.6%
Total Earnings (in millions of 2005 dollars)	24,168.27	27,416.26	28,511.77	29,436.42	30,105.83	30,921.50	31,758.31	35,328.26	41,419.56	47,267.21	61,514.93
Farm	1.6%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.0%	0.9%	0.8%	0.6%
Forestry, Fishing, Related Activities	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.4%
Mining	3.6%	3.8%	3.9%	3.9%	3.8%	3.7%	3.7%	3.6%	3.4%	3.3%	3.0%
Utilities	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%
Construction	7.5%	6.9%	6.7%	7.0%	6.9%	6.8%	6.7%	6.3%	5.8%	5.3%	4.5%
Manufacturing	5.9%	4.9%	4.8%	4.7%	4.7%	4.7%	4.6%	4.4%	4.1%	3.8%	3.3%
Wholesale Trade	4.2%	3.9%	4.0%	4.2%	4.1%	4.1%	4.1%	4.0%	3.9%	3.7%	3.5%
Retail Trade	8.8%	8.2%	8.4%	8.7%	8.7%	8.6%	8.5%	8.1%	7.6%	7.2%	6.4%
Transportation and Warehousing	3.6%	4.1%	4.4%	4.6%	4.6%	4.6%	4.6%	4.5%	4.5%	4.4%	4.3%
Information	1.5%	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.3%	1.3%
Finance and Insurance	3.4%	3.2%	3.2%	3.1%	3.1%	3.1%	3.1%	3.1%	3.2%	3.3%	3.4%
Real Estate/Rental and Lease	1.4%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.1%	1.1%	1.0%
Professional and Technical Services	4.6%	3.9%	4.0%	4.1%	4.2%	4.2%	4.3%	4.4%	4.7%	5.0%	5.4%
Management	0.1%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.4%	0.5%	0.6%	0.8%
Administrative and Waste Services	3.0%	3.3%	3.4%	3.5%	3.5%	3.6%	3.6%	3.7%	3.9%	4.1%	4.4%
Educational Services	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.9%	0.9%	1.1%
Health Care and Social Assistance	14.9%	17.2%	17.2%	16.9%	17.2%	17.4%	17.6%	18.6%	20.1%	21.4%	23.9%
Arts, Entertainment, and Recreation	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Accommodation and Food Services	3.4%	3.5%	3.6%	3.7%	3.8%	3.8%	3.8%	3.9%	4.0%	4.0%	4.1%
Other Services, Except Public Administration	4.5%	4.3%	4.2%	4.2%	4.2%	4.2%	4.2%	4.3%	4.3%	4.4%	4.4%
Federal Civilian Government	4.9%	5.5%	5.4%	5.3%	5.3%	5.3%	5.2%	5.1%	5.0%	4.8%	4.5%
Federal Military	2.8%	2.4%	2.5%	2.5%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%	2.2%
State and Local Government	17.8%	18.4%	17.9%	17.3%	17.3%	17.3%	17.3%	17.1%	16.9%	16.7%	16.1%
Total Personal Income per Capita (in 2005 dollars)	20,907	23,000	23,616	23,864	23,983	24,222	24,503	25,892	28,489	31,102	37,653
Woods & Poole Economics Wealth Index (U.S. = 100)	67.9	76.7	77.2	78.2	78.3	78.8	79.2	80.6	82.0	82.9	83.8

Table 4-19. Demographic and Employment Baseline Projections for Economic Impact Area TX-1 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Persons per Household (in number of people)	3.2	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.3
Mean Household Total Personal Income (in 2005 dollars)	67,317	74,865	76,593	77,019	77,040	77,417	77,962	81,618	90,088	99,282	122,725
Number of Households (in thousands)	510.57	552.77	563.40	575.95	588.62	601.67	614.61	662.04	723.19	768.65	854.98
Income <$10,000 (thousands of households, 2000$)	15.7%	13.7%	13.3%	13.1%	12.9%	12.7%	12.5%	11.4%	9.4%	8.1%	5.9%
Income $10,000 to $19,999	17.7%	15.5%	15.0%	14.7%	14.5%	14.3%	14.1%	12.9%	10.6%	9.1%	6.7%
Income $20,000 to $29,999	15.0%	13.4%	13.0%	12.7%	12.5%	12.4%	12.2%	11.1%	9.2%	7.8%	5.7%
Income $30,000 to $44,999	18.8%	20.0%	20.2%	20.2%	20.2%	20.3%	20.3%	20.0%	18.0%	15.5%	11.4%
Income $45,000 to $59,999	12.4%	14.2%	14.6%	14.9%	15.1%	15.3%	15.5%	16.8%	19.2%	20.3%	17.9%
Income $60,000 to $74,999	7.7%	8.7%	9.0%	9.2%	9.3%	9.5%	9.6%	10.5%	12.7%	14.8%	18.9%
Income $75,000 to $99,999	6.6%	7.5%	7.7%	7.9%	8.0%	8.1%	8.2%	9.0%	10.8%	12.6%	17.3%
Income $100,000 or more	6.1%	7.0%	7.2%	7.3%	7.4%	7.6%	7.7%	8.4%	10.1%	11.8%	16.3%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-20

Demographic and Employment Baseline Projections for Economic Impact Area TX-2

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	581.75	626.91	633.41	644.11	654.92	665.83	676.78	721.00	787.94	843.49	953.91
Age Under 19 Years	29.6%	29.1%	29.0%	29.0%	29.1%	29.1%	29.1%	29.3%	29.3%	29.2%	29.0%
Age 20 to 34	18.6%	18.3%	18.5%	18.4%	18.4%	18.4%	18.3%	18.0%	18.6%	18.9%	19.7%
Age 35 to 49	22.3%	20.6%	20.1%	19.8%	19.4%	19.2%	19.0%	18.6%	17.5%	17.2%	17.4%
Age 50 to 64	17.1%	19.2%	19.4%	19.6%	19.6%	19.7%	19.6%	18.9%	17.4%	16.4%	15.3%
Age 65 and over	12.4%	12.8%	13.0%	13.2%	13.5%	13.7%	14.0%	15.1%	17.1%	18.2%	18.5%
Median Age of Population (years)	39.1	40.5	40.5	40.6	40.5	40.5	40.4	40.1	39.2	38.2	36.5
White Population (in thousands)	58.3%	54.0%	53.3%	52.7%	52.0%	51.4%	50.8%	48.4%	44.7%	41.6%	35.6%
Black Population (in thousands)	9.3%	10.2%	10.3%	10.4%	10.5%	10.5%	10.6%	10.8%	11.3%	11.6%	12.4%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Asian and Pacific Islander Population (in thousands)	2.4%	3.4%	3.4%	3.5%	3.6%	3.6%	3.7%	4.0%	4.3%	4.5%	4.9%
Hispanic or Latino Population (in thousands)	29.6%	32.1%	32.6%	33.1%	33.6%	34.1%	34.6%	36.5%	39.4%	41.9%	46.7%
Male Population (in thousands)	50.2%	50.2%	50.2%	50.1%	50.1%	50.1%	50.1%	50.1%	50.0%	49.9%	49.6%
Total Employment (in thousands of jobs)	287.62	305.55	312.26	318.88	323.58	328.37	333.21	353.34	385.94	415.44	481.57
Farm Employment	7.4%	6.9%	6.8%	6.6%	6.6%	6.6%	6.5%	6.3%	6.0%	5.7%	5.2%
Forestry, Fishing, Related Activities	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%
Mining	2.4%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	3.0%	3.0%	2.9%
Utilities	1.1%	1.0%	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%
Construction	9.6%	8.9%	9.2%	10.2%	10.2%	10.2%	10.2%	10.2%	10.2%	10.2%	10.2%
Manufacturing	9.7%	8.8%	8.8%	8.8%	8.8%	8.7%	8.6%	8.3%	7.8%	7.3%	6.4%
Wholesale Trade	2.7%	2.7%	2.8%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Retail Trade	11.3%	11.2%	11.0%	11.0%	11.0%	11.1%	11.1%	11.2%	11.3%	11.4%	11.5%
Transportation and Warehousing	2.8%	2.7%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.5%	2.5%	2.3%
Information Employment	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%
Finance and Insurance	3.4%	4.5%	4.6%	4.5%	4.5%	4.6%	4.6%	4.8%	5.2%	5.5%	6.2%
Real Estate/Rental and Lease	3.4%	3.6%	3.6%	3.5%	3.5%	3.5%	3.6%	3.6%	3.8%	3.9%	4.2%
Professional and Technical Services	3.9%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.2%	4.2%
Management	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%
Administrative and Waste Services	4.6%	4.2%	4.4%	4.5%	4.5%	4.6%	4.6%	4.7%	4.8%	4.9%	5.2%
Educational Services	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.2%	1.3%

Table 4-20. Demographic and Employment Baseline Projections for Economic Impact Area TX-2 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	7.4%	8.2%	8.3%	8.2%	8.3%	8.4%	8.5%	8.8%	9.3%	9.7%	10.6%
Arts, Entertainment, and Recreation	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%
Accommodation and Food Services	5.6%	5.9%	5.9%	6.0%	6.0%	6.1%	6.1%	6.4%	6.8%	7.2%	8.1%
Other Services, Except Public Administration	6.5%	5.9%	5.9%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%
Federal Civilian Government	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.3%
Federal Military	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.3%
State and Local Government	12.9%	13.0%	12.5%	11.9%	11.8%	11.7%	11.5%	11.0%	10.2%	9.5%	8.1%
Total Earnings (in millions of 2005 dollars)	10,282.28	11,289.29	11,744.88	12,021.21	12,041.32	12,321.87	12,608.68	13,821.27	15,850.49	17,753.16	22,210.77
Farm	3.5%	2.0%	1.9%	1.9%	1.8%	1.8%	1.8%	1.7%	1.6%	1.6%	1.4%
Forestry, Fishing, Related Activities	0.7%	0.5%	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Mining	4.3%	4.1%	4.1%	4.0%	4.1%	4.1%	4.2%	4.3%	4.5%	4.6%	4.9%
Utilities	2.7%	2.8%	2.7%	2.8%	2.5%	2.5%	2.5%	2.6%	2.8%	2.9%	3.1%
Construction	11.7%	11.3%	11.8%	13.2%	13.5%	13.4%	13.3%	13.0%	12.6%	12.2%	11.5%
Manufacturing	20.2%	18.8%	19.1%	19.2%	19.2%	19.2%	19.2%	19.0%	18.6%	18.3%	17.4%
Wholesale Trade	3.5%	4.5%	4.9%	5.3%	4.4%	4.4%	4.4%	4.5%	4.6%	4.7%	4.9%
Retail Trade	8.1%	7.9%	7.9%	7.9%	8.0%	8.0%	7.9%	7.7%	7.4%	7.2%	6.7%
Transportation and Warehousing	3.2%	3.4%	3.4%	3.3%	3.2%	3.2%	3.2%	3.1%	3.0%	2.8%	2.6%
Information	0.8%	0.7%	0.7%	0.6%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%
Finance and Insurance	3.0%	3.1%	3.0%	2.8%	3.2%	3.2%	3.3%	3.5%	3.8%	4.0%	4.7%
Real Estate/Rental and Lease	1.5%	2.1%	2.2%	2.2%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%	2.0%
Professional and Technical Services	3.9%	4.1%	4.0%	4.0%	3.8%	3.9%	3.9%	4.0%	4.1%	4.3%	4.5%
Management	0.1%	0.2%	0.2%	0.1%	0.4%	0.4%	0.5%	0.5%	0.6%	0.6%	0.8%
Administrative and Waste Services	2.5%	2.5%	2.5%	2.5%	2.7%	2.7%	2.7%	2.8%	2.9%	3.1%	3.3%
Educational Services	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.6%
Health Care and Social Assistance	6.8%	7.9%	7.8%	7.6%	7.9%	7.9%	8.0%	8.4%	9.1%	9.6%	10.7%
Arts, Entertainment, and Recreation	0.4%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Accommodation and Food Services	2.2%	2.5%	2.5%	2.5%	2.4%	2.4%	2.5%	2.6%	2.8%	2.9%	3.4%
Other Services, Except Public Administration	5.2%	4.9%	4.8%	4.7%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.7%
Federal Civilian Government	0.9%	0.9%	0.9%	0.8%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.8%
Federal Military	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
State and Local Government	13.9%	14.4%	13.6%	12.7%	12.9%	12.8%	12.7%	12.3%	11.6%	11.1%	9.9%
Total Personal Income per Capita (in 2005 dollars)	29,554	32,870	34,011	34,322	34,024	34,254	34,549	36,104	39,100	42,144	49,755
Woods & Poole Economics Wealth Index (U.S. = 100)	78.4	87.7	88.4	88.6	87.7	87.8	88.0	88.8	89.9	90.8	92.8

Table 4-20. Demographic and Employment Baseline Projections for Economic Impact Area TX-2 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Persons per Household (in number of people)	2.7	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.8
Mean Household Total Personal Income (in 2005 dollars)	81,195	91,618	94,435	94,838	93,574	93,741	94,123	97,474	105,974	115,407	139,471
Number of Households (in thousands)	211.75	224.92	228.13	233.11	238.13	243.30	248.42	267.05	290.72	308.02	340.30
Income <$10,000 (thousands of households, 2000$)	9.6%	8.3%	8.0%	7.9%	7.8%	7.7%	7.6%	6.9%	5.9%	5.1%	3.7%
Income $10,000 to $19,999	12.9%	11.2%	10.8%	10.6%	10.6%	10.4%	10.3%	9.4%	8.1%	7.0%	5.2%
Income $20,000 to $29,999	12.9%	11.2%	10.9%	10.7%	10.7%	10.5%	10.3%	9.5%	8.2%	7.2%	5.3%
Income $30,000 to $44,999	17.5%	16.2%	15.8%	15.5%	15.5%	15.3%	15.1%	14.0%	12.1%	10.5%	7.8%
Income $45,000 to $59,999	14.3%	15.3%	15.3%	15.3%	15.3%	15.3%	15.3%	15.6%	14.8%	13.3%	9.6%
Income $60,000 to $74,999	11.2%	12.9%	13.4%	13.6%	13.7%	13.9%	14.1%	15.1%	16.7%	17.4%	15.7%
Income $75,000 to $99,999	10.9%	12.7%	13.1%	13.4%	13.4%	13.7%	13.9%	15.0%	17.3%	20.0%	26.3%
Income $100,000 or more	10.5%	12.2%	12.7%	13.0%	13.0%	13.2%	13.4%	14.5%	16.8%	19.4%	26.4%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

ource: Woods & Poole Economics, Inc., 2013.

Table 4-21

Demographic and Employment Baseline Projections for Economic Impact Area TX-3

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	5,518.20	6,202.21	6,309.03	6,442.79	6,577.78	6,713.83	6,850.35	7,400.96	8,234.48	8,927.83	10,309.09
Age Under 19 Years	30.7%	30.3%	30.1%	30.1%	30.1%	30.1%	30.1%	30.0%	29.7%	29.5%	29.1%
Age 20 to 34	22.2%	21.8%	21.8%	21.7%	21.6%	21.5%	21.4%	20.9%	21.1%	21.1%	21.2%
Age 35 to 49	22.8%	21.3%	21.0%	20.8%	20.5%	20.4%	20.3%	20.0%	19.2%	18.7%	18.5%
Age 50 to 64	15.8%	17.5%	17.7%	17.8%	17.9%	17.9%	17.9%	17.4%	16.4%	15.9%	15.5%
Age 65 and over	8.5%	9.1%	9.3%	9.6%	9.8%	10.1%	10.4%	11.6%	13.6%	14.7%	15.7%
Median Age of Population (years)	37.4	38.2	38.3	38.4	38.5	38.5	38.6	38.7	38.8	38.8	38.4
White Population (in thousands)	45.8%	41.7%	41.3%	40.6%	40.0%	39.3%	38.7%	36.2%	32.8%	30.0%	25.1%
Black Population (in thousands)	17.6%	17.8%	17.6%	17.5%	17.4%	17.3%	17.2%	16.7%	16.0%	15.4%	14.2%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Asian and Pacific Islander Population (in thousands)	5.7%	6.5%	6.5%	6.7%	6.8%	6.9%	7.1%	7.6%	8.3%	8.9%	10.1%
Hispanic or Latino Population (in thousands)	30.6%	33.8%	34.2%	34.9%	35.5%	36.1%	36.7%	39.1%	42.5%	45.3%	50.4%
Male Population (in thousands)	49.8%	49.8%	49.8%	49.8%	49.8%	49.8%	49.8%	49.7%	49.6%	49.5%	49.2%
Total Employment (in thousands of jobs)	3,218.66	3,591.39	3,674.80	3,780.47	3,852.39	3,925.65	4,000.29	4,312.97	4,827.44	5,301.86	6,392.23
Farm Employment	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Forestry, Fishing, Related Activities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	2.8%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.0%	3.0%	2.9%
Utilities	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%
Construction	8.0%	7.6%	7.3%	7.5%	7.6%	7.6%	7.6%	7.7%	7.8%	7.9%	8.1%
Manufacturing	7.4%	6.9%	7.0%	7.1%	7.0%	6.9%	6.8%	6.4%	5.8%	5.3%	4.5%
Wholesale Trade	4.5%	4.4%	4.5%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
Retail Trade	10.2%	9.4%	9.4%	9.4%	9.4%	9.4%	9.4%	9.3%	9.1%	9.0%	8.7%
Transportation and Warehousing	4.3%	4.2%	4.3%	4.4%	4.4%	4.3%	4.3%	4.2%	4.1%	4.0%	3.8%
Information Employment	1.5%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
Finance and Insurance	4.5%	5.4%	5.5%	5.3%	5.3%	5.3%	5.3%	5.3%	5.4%	5.4%	5.4%
Real Estate/Rental and Lease	4.1%	4.2%	4.2%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	3.9%	3.9%
Professional and Technical Services	7.8%	7.9%	7.9%	8.1%	8.1%	8.1%	8.1%	8.3%	8.4%	8.5%	8.8%
Management	0.6%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Administrative and Waste Services	7.4%	7.3%	7.5%	7.6%	7.6%	7.7%	7.7%	7.9%	8.1%	8.3%	8.7%
Educational Services	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.8%	1.8%	1.8%	1.8%

Table 4-21. Demographic and Employment Baseline Projections for Economic Impact Area TX-3 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	8.2%	9.1%	9.2%	9.1%	9.2%	9.3%	9.4%	9.8%	10.5%	11.0%	12.1%
Arts, Entertainment, and Recreation	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Accommodation and Food Services	6.5%	6.7%	6.8%	6.8%	6.9%	6.9%	6.9%	7.0%	7.2%	7.3%	7.6%
Other Services, Except Public Administration	6.0%	5.8%	5.8%	5.7%	5.7%	5.7%	5.8%	5.8%	5.9%	6.0%	6.1%
Federal Civilian Government	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.7%	0.7%	0.6%
Federal Military	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%
State and Local Government	10.3%	9.9%	9.7%	9.3%	9.3%	9.2%	9.2%	8.9%	8.6%	8.3%	7.8%
Total Earnings (in millions of 2005 dollars)	186,536.20	201,343.67	209,492.83	216,460.02	222,664.44	228,935.92	235,382.66	263,020.74	310,620.91	356,739.41	470,279.90
Farm	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%
Forestry, Fishing, Related Activities	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Mining	12.3%	8.2%	8.3%	8.1%	7.9%	8.0%	8.0%	8.1%	8.2%	8.3%	8.3%
Utilities	1.6%	1.7%	1.7%	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
Construction	8.2%	8.2%	7.9%	8.1%	8.1%	8.1%	8.0%	7.9%	7.7%	7.5%	7.1%
Manufacturing	11.7%	11.0%	11.3%	11.6%	11.5%	11.3%	11.2%	10.7%	9.9%	9.3%	8.3%
Wholesale Trade	6.2%	7.0%	7.4%	7.9%	7.9%	8.0%	8.0%	8.1%	8.2%	8.3%	8.4%
Retail Trade	5.2%	5.0%	4.9%	4.9%	4.8%	4.8%	4.7%	4.5%	4.2%	4.0%	3.5%
Transportation and Warehousing	5.6%	6.0%	6.4%	6.7%	6.7%	6.6%	6.6%	6.3%	6.0%	5.7%	5.2%
Information	1.7%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.0%
Finance and Insurance	5.5%	5.3%	5.3%	5.0%	5.0%	5.0%	5.0%	5.1%	5.1%	5.2%	5.2%
Real Estate/Rental and Lease	2.4%	1.7%	1.6%	1.4%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%
Professional and Technical Services	10.8%	11.9%	11.9%	12.0%	12.1%	12.2%	12.3%	12.7%	13.2%	13.6%	14.5%
Management	0.6%	1.5%	1.7%	1.9%	1.9%	1.9%	2.0%	2.1%	2.3%	2.5%	2.9%
Administrative and Waste Services	4.4%	4.6%	4.7%	4.7%	4.8%	4.8%	4.9%	5.0%	5.2%	5.4%	5.8%
Educational Services	1.0%	1.1%	1.0%	1.0%	1.0%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%
Health Care and Social Assistance	6.5%	7.7%	7.5%	7.3%	7.3%	7.4%	7.5%	7.9%	8.5%	8.9%	9.9%
Arts, Entertainment, and Recreation	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%
Accommodation and Food Services	2.3%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.6%	2.6%
Other Services, Except Public Administration	3.1%	3.4%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.4%
Federal Civilian Government	1.7%	1.7%	1.6%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.3%	1.2%
Federal Military	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
State and Local Government	8.3%	9.0%	8.6%	8.2%	8.1%	8.1%	8.1%	7.9%	7.8%	7.6%	7.3%
Total Personal Income per Capita (in 2005 dollars)	39,184	39,270	40,486	40,855	41,434	41,679	42,021	43,955	47,917	52,096	62,960

Table 4-21. Demographic and Employment Baseline Projections for Economic Impact Area TX-3 (continued)

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Woods & Poole Economics Wealth Index (U.S. = 100)	84.6	92.1	92.7	93.3	93.1	93.1	93.0	92.8	92.6	92.7	93.4
Persons per Household (in number of people)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9
Mean Household Total Personal Income (in 2005 dollars)	107,917	111,833	114,840	115,321	116,414	116,532	116,965	121,262	132,684	145,707	180,074
Number of Households (in thousands)	2,003.61	2,177.90	2,224.21	2,282.53	2,341.14	2,401.28	2,461.04	2,682.72	2,973.74	3,192.07	3,604.44
Income <$10,000 (thousands of households, 2000$)	8.7%	8.0%	7.8%	7.7%	7.6%	7.5%	7.4%	6.9%	6.0%	5.3%	4.1%
Income $10,000 to $19,999	10.9%	10.1%	9.9%	9.8%	9.6%	9.5%	9.4%	8.8%	7.6%	6.8%	5.2%
Income $20,000 to $29,999	11.9%	11.1%	10.8%	10.7%	10.6%	10.5%	10.4%	9.7%	8.4%	7.6%	5.8%
Income $30,000 to $44,999	16.7%	15.7%	15.4%	15.2%	15.0%	14.9%	14.7%	13.8%	12.1%	10.8%	8.3%
Income $45,000 to $59,999	14.0%	14.2%	14.3%	14.3%	14.2%	14.3%	14.3%	14.1%	12.9%	11.6%	8.9%
Income $60,000 to $74,999	10.9%	11.6%	11.8%	11.9%	12.0%	12.1%	12.3%	12.9%	14.2%	14.6%	12.8%
Income $75,000 to $99,999	11.4%	12.4%	12.7%	12.8%	13.0%	13.2%	13.3%	14.3%	16.3%	18.0%	21.4%
Income $100,000 or more	15.5%	16.9%	17.3%	17.5%	17.8%	18.0%	18.2%	19.6%	22.5%	25.2%	33.6%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; and persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-22

Peak Employment Projected from Cumulative OCS Programs as a Percent of Total Employment

EIA	Low Case				High Case			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	6,274	2030	1,132,220	0.55%	9,795	2031	1,151,200	0.85%
TX-2	2,556	2031	421,620	0.61%	4,154	2031	421,620	0.99%
TX-3	53,117	2030	5,301,860	1.00%	78,387	2031	5,402,030	1.45%
Louisiana (LA)								
LA-1	3,459	2030	220,300	1.57%	5,700	2031	223,080	2.56%
LA-2	10,023	2030	448,580	2.23%	15,733	2031	455,290	3.46%
LA-3	13,076	2030	871,690	1.50%	20,868	2031	883,890	2.36%
LA-4	6,753	2030	878,380	0.77%	10,803	2031	885,790	1.22%
Florida (FL)								
FL-1	1,843	2031	633,130	0.29%	2,983	2031	633,130	0.47%
FL-2	3,630	2031	409,990	0.89%	5,910	2031	409,990	1.44%
FL-3	3,191	2031	2,550,120	0.13%	5,216	2031	2,550,120	0.20%
FL-4	2,284	2031	4,873,290	0.05%	3,729	2031	4,873,290	0.08%
Alabama (AL)								
AL-1	4,344	2030	482,560	0.90%	7,106	2031	488,970	1.45%
Mississippi (MS)								
MS-1	3,369	2030	284,280	1.19%	5,450	2031	286,640	1.90%

Sources: Peak employment output from BOEM's economic impact model (MAG-PLAN).
Baseline employment projections based on Woods & Poole Economics, Inc. (2013).

Table 4-23

Baseline Employment Projections (in thousands) by Economic Impact Area

Model Year	Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4
	2010	805.32	305.55	3,591.39	177.41	325.85	669.39	744.81	240.12	373.38	473.21	322.32	1,842.54	3,351.08
	2011	819.02	312.26	3,674.80	175.82	326.83	667.49	745.46	242.03	378.73	483.35	323.02	1,880.65	3,452.11
	2012	833.79	318.88	3,780.47	175.74	339.22	674.34	749.69	244.21	379.89	489.04	324.07	1,915.18	3,548.46
	2013	848.38	323.58	3,852.39	177.96	344.71	684.23	756.58	246.33	385.02	495.84	328.11	1,945.11	3,610.06
	2014	863.18	328.37	3,925.65	180.22	350.28	694.25	763.49	248.45	390.21	502.71	332.19	1,975.41	3,672.52
	2015	878.21	333.21	4,000.29	182.51	355.90	704.39	770.43	250.60	395.45	509.67	336.31	2,006.07	3,735.84
	2016	893.45	338.13	4,076.29	184.81	361.59	714.65	777.41	252.75	400.77	516.72	340.49	2,037.10	3,800.03
	2017	908.92	343.12	4,153.75	187.14	367.36	725.01	784.42	254.92	406.14	523.84	344.72	2,068.51	3,865.12
	2018	924.62	348.20	4,232.62	189.51	373.19	735.51	791.46	257.09	411.60	531.06	349.01	2,100.28	3,931.07
	2019	940.55	353.34	4,312.97	191.90	379.08	746.15	798.52	259.29	417.11	538.36	353.35	2,132.46	3,997.92
	2020	956.70	358.59	4,394.82	194.33	385.04	756.89	805.62	261.49	422.71	545.75	357.75	2,165.03	4,065.70
	2021	973.03	363.90	4,478.12	196.79	391.03	767.72	812.68	263.69	428.36	553.20	362.20	2,197.79	4,133.93
	2022	989.64	369.29	4,563.01	199.27	397.10	778.70	819.81	265.92	434.08	560.75	366.71	2,231.04	4,203.30
	2023	1,006.54	374.76	4,649.50	201.79	403.28	789.84	827.01	268.16	439.87	568.41	371.27	2,264.80	4,273.84
	2024	1,023.72	380.31	4,737.64	204.33	409.54	801.14	834.26	270.42	445.75	576.17	375.89	2,299.07	4,345.56
	2025	1,041.20	385.94	4,827.44	206.92	415.91	812.61	841.58	272.69	451.70	584.04	380.57	2,333.86	4,418.49
	2026	1,058.80	391.67	4,918.80	209.53	422.25	824.09	848.82	274.97	457.71	591.96	385.32	2,368.66	4,491.42
	2027	1,076.69	397.48	5,011.89	212.17	428.68	835.74	856.11	277.27	463.80	599.99	390.13	2,403.98	4,565.56
	2028	1,094.89	403.38	5,106.74	214.85	435.22	847.56	863.47	279.59	469.97	608.12	395.00	2,439.83	4,640.92
	2029	1,113.40	409.37	5,203.38	217.56	441.85	859.54	870.89	281.92	476.23	616.37	399.93	2,476.22	4,717.53
	2030	1,132.22	415.44	5,301.86	220.30	448.58	871.69	878.38	284.28	482.56	624.72	404.92	2,513.15	4,795.40
	2031	1,151.20	421.62	5,402.03	223.08	455.29	883.89	885.79	286.64	488.97	633.13	409.99	2,550.12	4,873.29
	2032	1,170.49	427.89	5,504.09	225.88	462.11	896.25	893.27	289.03	495.46	641.66	415.12	2,587.65	4,952.44
	2033	1,190.12	434.26	5,608.08	228.73	469.02	908.79	900.81	291.43	502.04	650.30	420.32	2,625.72	5,032.88
	2034	1,210.07	440.71	5,714.04	231.61	476.04	921.50	908.41	293.85	508.70	659.05	425.58	2,664.35	5,114.62
	2035	1,230.35	447.27	5,821.99	234.53	483.16	934.39	916.07	296.30	515.46	667.93	430.90	2,703.56	5,197.70

Table 4-23. Baseline Employment Projections (in thousands) by Economic Impact Area (continued)

Model Year	Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4
	2036	1,250.85	453.93	5,931.82	237.48	490.26	947.33	923.67	298.75	522.28	676.87	436.32	2,742.85	5,280.79
	2037	1,271.68	460.68	6,043.72	240.47	497.46	960.44	931.34	301.23	529.20	685.93	441.81	2,782.71	5,365.21
	2038	1,292.86	467.54	6,157.72	243.50	504.77	973.74	939.06	303.73	536.21	695.11	447.36	2,823.15	5,450.98
	2039	1,314.40	474.50	6,273.88	246.57	512.19	987.23	946.85	306.25	543.31	704.41	452.98	2,864.18	5,538.12
	2040	1,336.29	481.57	6,392.23	249.67	519.72	1,000.90	954.71	308.79	550.51	713.84	458.68	2,905.81	5,626.66
	2041	1,358.55	488.74	6,512.81	252.81	527.36	1,014.76	962.62	311.35	557.80	723.39	464.44	2,948.04	5,716.61
	2042	1,381.17	496.01	6,635.67	256.00	535.11	1,028.81	970.61	313.93	565.19	733.08	470.28	2,990.89	5,807.99
	2043	1,404.18	503.40	6,760.84	259.22	542.97	1,043.06	978.66	316.53	572.67	742.89	476.19	3,034.35	5,900.84
	2044	1,427.57	510.89	6,888.38	262.49	550.95	1,057.50	986.78	319.16	580.26	752.83	482.18	3,078.45	5,995.18
	2045	1,451.35	518.50	7,018.32	265.79	559.05	1,072.14	994.97	321.80	587.95	762.91	488.24	3,123.19	6,091.02
	2046	1,475.52	526.22	7,150.71	269.14	567.26	1,086.99	1,003.22	324.47	595.73	773.12	494.38	3,168.58	6,188.39
	2047	1,500.10	534.05	7,285.60	272.53	575.60	1,102.04	1,011.54	327.16	603.62	783.47	500.59	3,214.63	6,287.32
	2048	1,525.08	542.00	7,423.04	275.96	584.06	1,117.30	1,019.93	329.88	611.62	793.95	506.89	3,261.35	6,387.83
	2049	1,550.48	550.07	7,563.07	279.43	592.64	1,132.77	1,028.39	332.61	619.72	804.58	513.26	3,308.75	6,489.95
	2050	1,576.31	558.26	7,705.73	282.95	601.35	1,148.46	1,036.92	335.37	627.93	815.35	519.71	3,356.84	6,593.70
	2051	1,602.56	566.57	7,851.09	286.51	610.19	1,164.36	1,045.52	338.15	636.25	826.26	526.25	3,405.62	6,699.11
	2052	1,629.26	575.01	7,999.20	290.12	619.16	1,180.48	1,054.20	340.95	644.67	837.32	532.86	3,455.12	6,806.21
	2053	1,656.39	583.57	8,150.09	293.77	628.26	1,196.83	1,062.94	343.78	653.21	848.53	539.56	3,505.33	6,915.01
	2054	1,683.98	592.26	8,303.83	297.47	637.49	1,213.40	1,071.76	346.63	661.86	859.88	546.34	3,556.28	7,025.56
	2055	1,712.03	601.07	8,460.48	301.22	646.86	1,230.21	1,080.65	349.51	670.63	871.39	553.21	3,607.96	7,137.87

Notes: Actual Woods & Poole data for 2010 through 2020, 2025, 2030, 2035, and 2040.
Missing estimates through 2040 calculated using average annual growth rate for the 5-year period; projections after 2040 calculated using the average annual growth rate from 2035 to 2040.

Source: Woods & Poole Economics, Inc., 2013.

Table 4-24

Existing Coastal Infrastructure Related to OCS Activities in the Gulf of Mexico

Infrastructure	Texas	Louisiana	Mississippi	Alabama	Florida	Total
Pipeline Landfalls[1]	13	109	3	4	0	129
Platform Fabrication Yards[2]	12	37	4	1	0	54
Shipyards[2]	32	64	9	18	14	137
Pipe-Coating Facilities[2]	9	6	0	2	2	19
Supply Bases[2]	32	55	2	7	0	96
Ports[2]	11	14	3	1	5	34
Waste Disposal Facilities[2]	16	29	3	3	2	53
Natural Gas Storage Facilities[2]	13	8	0	1	0	22
Helicopter Hubs[2]	118	115	4	4	0	241
Pipeline Shore Facilities[2]	13	40	0	0	0	53
Barge Terminals[2]	110	122	6	6	8	252
Tanker Ports[2]	4	6	0	0	0	10
Gas Processing Plants[2]	39	44	1	13	1	98
Refineries[2]	18	15	1	3	0	37
Petrochemical Plants[2]	126	66	2	9	13	216

[1] Source: USDOI, BOEMRE, 2011.
[2] Source: Dismukes, 2011.

Table 4-25

Gulf of Mexico Counties and Parishes with Concentrated Levels
of Oil- and Gas-Related Infrastructure

Low Concentration		Medium Concentration		High Concentration	
County/Parish	State	County/Parish	State	County/Parish	State
Escambia	FL	Bay	FL	Mobile	AL
Manatee	FL	Hillsborough	FL	Cameron	LA
Lafayette	LA	Calcasieu	LA	Jefferson	LA
St. John the Baptist	LA	Iberia	LA	Lafourche	LA
West Baton Rouge	LA	Orleans	LA	Plaquemines	LA
Harrison	MS	St. Bernard	LA	St. Mary	LA
Aransas	TX	St. Charles	LA	Brazoria	TX
Cameron	TX	St. James	LA	Galveston	TX
Fort Bend	TX	Vermilion	LA	Harris	TX
Matagorda	TX	Jackson	MS	Jefferson	TX
Montgomery	TX	Calhoun	TX		
Orange	TX	Nueces	TX		
		San Patricio	TX		

Source: Kaplan et al., 2011.

Table 4-26

Deepwater Horizon Waste Landfill Destination

Landfill Name and Location	Percent Minority Living within 1-Mile Radius of Site	Total Population Living within 1-Mile Radius of Site (2000 Census)	Percentage of Total *Deepwater Horizon* Liquid Waste Collected	Percentage of Total *Deepwater Horizon* Solid Waste Collected
Liquid Environmental Solutions, Mobile, LA	95.80%	4,257	13.17%	0.00%
Oil Recovery Company, Mobile, LA	93.90%	3,238	0.08%	0.00%
Cliff Berry, Inc. – Miami, FL	92.80%	24,768	>0.58%	0.00%
River Birch Industries Landfill, Avondale, LA	92.20%	167	16.99%	8.67%
Jefferson Parish Waste Management, Avondale, LA	91.40%	120	0.00%	0.02%
Sunbelt Crushing, Mobile, LA	76.80%	3,173	0.00%	0.29%
Chemical Waste Management, Emelle, LA	75.20%	33	1.02%	0.00%
WM Springhill Regional Landfill, Campbelton, FL	74.30%	109	0.00%	23.67%
Allied Waste/BFI Colonial Landfill, Sorrento, LA	74.10%	153	0.00%	21.98%
Allied Waste Recycling Center, Metairie, LA	63.50%	14,420	0.00%	0.06%
WH Chastang Landfill, Mount Vernon, AL	62.50%	123	0.00%	8.93%
Clearview Landfill Lake, MS	50.90%	55	0.44%	14.92%
Cliff Berry, Inc. – Tampa, FL	50.50%	1,817	>0.58%	0.00%
Apex Environmental Services, Theodore, AL	50.40%	383	17.44%	0.00%
Newpark Environmental Services Site Code 5102, Morgan City, LA	35.90%	4,237	2.74%	0.00%
Liquid Environmental Solutions, Mobile, AL	63.30%	4,257	13.17%	0.00%
Newpark Environmental Mud Facility, Venice, LA	50.00%	2	10.90%	0.00%
Oil Recovery Company, Mobile, AL	41.70%	3,238	0.08%	0.00%
Chemical Waste Management, Emelle, LA	36.40%	33	1.02%	0.00%
Newpark Environmental Services Site Code 2913, Fourchon, LA	33.30%	3	30.14%	0.00%
Vacco Marine, Houma, LA	29.20%	525	0.16%	0.00%
River Birch Industries Landfill, Avondale, LA	28.10%	167	16.99%	8.67%
Jefferson Parish Waste Management, Avondale, LA	26.70%	120	0.00%	0.02%
Apex Environmental Services, Theodore, AL	26.20%	383	17.44%	0.00%
Allied Waste/BFI Colonial Landfill, Sorrento, LA	25.00%	153	0.00%	21.98%
WM Pecan Grove, Pass Christian, MS	14.40%	290	0.00%	3.28%
Baldwin County Magnolia Landfill, Summerdale, AL	13.70%	446	0.00%	11.18%
MBO LLC (Lacassine Oilfield Services), Lacassine, LA	12.90%	85	3.82%	0.00%
Coast Guard Rd Sanitary Landfill, Sorrento, LA	0.00%	0	0.00%	8.05%

Source: British Petroleum, 2010.

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APPENDIX A

AIR QUALITY OFFSHORE MODELING ANALYSIS

APPENDIX A. AIR QUALITY OFFSHORE MODELING ANALYSIS

Introduction

This Appendix discusses the coastal dispersion modeling analysis and the potential impacts of offshore emission from a CPA proposed action to onshore air quality. The latest version of the Offshore and Coastal Dispersion Model (Version 5.0, dated May 16, 2005) was used to calculate impacts. The objective of the analysis was to determine if the impacts from the proposed actions would significantly affect the environment, particularly public health and public welfare.

Background

The Clean Air Act, which was last amended in 1990, requires the U.S. Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS, [40 CFR part 50]) for pollutants considered harmful to public health and the environment. The USEPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants. These pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution (listed as $PM_{2.5}$ and PM_{10}), and sulfur dioxide.

The NAAQS were developed to protect the public health and welfare while allowing for an adequate margin of safety. Primary NAAQS protect the public health including sensitive subpopulations such as infants and the elderly. Secondary NAAQS standards protect public welfare such as the prevention of aquatic acidification, plant leaf damage, or visibility impairment. Thus, for NEPA evaluation purposes, it is reasonable to presume that concentrations of emissions from offshore activities that, following transport to shore, which do not cause exceedances of the NAAQS and are below BOEM's maximum allowable increases, will have minimal impacts to onshore air quality.

The Outer Continental Shelf Lands Act requires the Secretary of the Interior to promulgate and administer regulations for compliance with the NAAQS to the extent that the authorized activities significantly affect the air quality of any state. These regulations apply in the area of the proposed actions and alternatives.

BOEM-regulated pollutants include carbon monoxide (CO), suspended particulates, sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOC's). The original NAAQS particulate standard was for total suspended particulates (TSP's), which BOEM adopted. This standard has been replaced by USEPA in their regulations with the PM_{10} and $PM_{2.5}$ (particulate matter equal to or below 10 µm and equal to or below 2.5µm in size) because these specific size classifications better define the size range that has the greatest environmental impact. BOEM's regulations use the TSP designation, but for purposes of this NEPA analysis, BOEM determined levels of PM_{10} and $PM_{2.5}$ so that our data are compatible with USEPA's data. This is just one example of where the U.S. Environmental Protection Agency's NAAQS and BOEM's regulations may be somewhat different. As another example, BOEM's regulations employ 3-hour, 24-hour, and annual standards while USEPA has set 1-hour standards to limit pollutant spikes that are not detectable when concentrations are averaged over a longer time period. Both types of particulate designations are included in this Appendix.

For OCS oil and gas activities in the GOM west of 87.5° W. longitude, BOEM has developed evaluation criteria and screening tools. Refer to Chapter 4.2.1.1 of *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement* (WPA 233/CPA 231 Supplemental EIS).

According to the Clean Air Act Amendments, the air quality in national parks, national wilderness areas, national monuments, and national seashores (42 U.S.C. § 7470) must be preserved. The Clean Air Act Amendments establish Class I and II areas, where emissions of particulate matter and sulfur dioxide are to be restricted. The restrictions are most severe in Class I areas and are progressively less restrictive in Class II areas. In the Gulf of Mexico, the Breton National Wilderness Area, 95 mi (153 km) from the proposed CPA lease sale area, is the Class I area most likely to be impacted by OCS activity. At the Breton National Wilderness Area, if modeled emissions from offshore activities result below the U.S. Environmental Protection Agency's SIL's, it is reasonable to presume for NEPA evaluation purposes that they have negligible impacts to the air quality on this pristine Federal area.

Offshore Coastal Dispersion Model

The Offshore and Coastal Dispersion Model Version 5 (OCD 5 model) was developed by USEPA in conjunction with BOEM's predecessor agency, the Minerals Management Service, in the late 1980's, and the model was formally approved for use in January 1988. The OCD 5 model is a coastal dispersion model that was formulated to estimate shoreline concentrations resulting from releases taking place from offshore petroleum drilling platforms. The developers suggest that direct turbulence measurements be used to estimate the dispersion parameters over water. As the plume comes ashore, dispersion is estimated for the effect of transport over land using traditional techniques (Turner and Schulze, 2007).

The OCD 5 model input data comprises source-specific data as well as meteorological data. The source-specific data includes location of activities, emission rate information for all sources associated with activities at the given location, and stack parameters for each source. The model requires both over-land and over-water meteorological data to determine the potential onshore impacts of the offshore operations. These data include overland surface characteristics such as surface roughness and over-water data such as water temperature, over-water air temperature, over-water dew point, over-water wind speed, and over-water wind direction. These data are usually obtained from overland meteorological stations, radiosonde observations, and offshore buoys closest to emission sources.

The model parameters are arranged to consider onshore locations (receptors) at which the OCD 5 model will predict the pollutant concentrations of the modeled emission sources. Receptors are identified on the shoreline and at nearby Class I areas. Although the OCD 5 model does not include algorithms for parameters such as regional haze and acid deposition, its relatively simpler data processing makes it an efficient model for use in predicting pollutant impacts from offshore sources.

The OCD 5 model was chosen to analyze the proposed impacts because it performs best when meteorological data is collected over the water. The OCD 5 model was approved for use by the Director of the Minerals Management Service (currently BOEM), and it is listed as an approved air quality model in Appendix W of 40 CFR part 51. More recently, BOEM's Director approved the use of the California-PUFF model (CALPUFF), another approved dispersion model listed in Appendix W of 40 CFR part 51. However, the OCD 5 model was chosen because BOEM continues to believe it is the more conservative of the two models.

The OCD model does not include a simulation of onshore ozone levels. Several prior studies have demonstrated that OCS activities have only a small contribution to onshore ozone formation. Because the offshore activities' contribution to onshore ozone have been shown to be very small, BOEM chose to run the OCD model. The studies that support this decision include the *Gulf of Mexico Air Quality Study* (Systems Applications International et al., 1995), in which this Agency used the Urban Airshed Model (UAM-V) to assess the potential impacts of OCS activity in the WPA/CPA on USEPA -designated ozone nonattainment areas in urban onshore Texas and Louisiana. Relative to onshore contributors, OCS contributors to onshore ozone formation were low. The *Gulf of Mexico Air Quality Study* was followed by a study in 2000 that used the year 2000 Gulfwide emissions to assess the OCS contribution to onshore ozone in the Houston/Brazoria/Galveston region of Texas. The Comprehensive Air Quality Model with extensions (CAMx) was used to model contribution during an August 2000 ozone episode (Yarwood et al., 2004). The OCS contributions to ozone exceedances were minor. Yarwood et al. (2004) used a photochemical model to analyze the Year 2000 Gulfwide Emissions Inventory (GWEI) and selected the Houston-Galveston-Brazoria nonattainment area since it has the most severe ozone problem in the Gulf of Mexico region (System Applications International et al., 1995). One of the main relevant findings in Yarwood et al. (2004) is as follow: "The average impact of the year 2000 GWEI emissions on 8-hour ozone levels above 85 ppb in Houston area is 0.2 ppb; although larger impacts may occur over the Gulf of Mexico." Haney et al. (2008) performed a modeling investigation using the year 2000 and year 2005 GWEI's in the CPA to evaluate the impact of offshore emissions on offshore and onshore ozone air quality, in which they proposed an emission-reduction scenario. They found a particular ozone episode that the onshore impact from all offshore oil-and-gas-related sources was small but generally larger than those estimates using the year 2000 inventory. They noticed higher simulated ozone concentrations from the year 2005 emissions due to increases in NO_x and VOC concentrations.

A second follow-up study was conducted in 2008 using the updated year 2005 Gulfwide Emission Inventory Study to model ozone formation in Louisiana, Mississippi, Alabama, and Florida based on an August 1999 ozone episode (Haney et al., 2008). In this study, OCS oil and gas activity contributed only slightly to the simulated onshore ozone exceedances.

A third follow-up study will conducted by March 2014. This study will use the updated *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) to model ozone formation, and it will include a 1-hour inventory.

OCD Model Protocol

The OCD 5 model was used to analyze a CPA proposed action's impacts on the onshore community. BOEM's regulations at 30 CFR § 550.303 cite that an approved model should be used to assess impacts. The USEPA lists approved models in 40 CFR part 51, appendix W 7.2.4., "Modeling Guidance for Other Governmental Programs." The model was used to compute concentrations of sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic carbon compounds (VOC's), carbon monoxide (CO), and particulate matter below 10 micrometers (PM_{10}) and below 2.5 micrometers ($PM_{2.5}$) in size.

BOEM's regulations do not include ozone as it is not directly emitted into the air from OCS oil and gas activities. BOEM does regulate the pollutants, VOC and NO_2, which are precursors to ozone. Ozone formation from VOC's and NO_2 is dependent upon a photochemical reaction in the ambient air that includes heat and sunlight. Ozone formation is a problem in onshore urban areas with many sources of pollutants. The OCD model cannot simulate ozone generation. Several studies that BOEM has conducted and that are discussed above have shown that OCS activities are only a small contributor to onshore ozone exceedance so there was no need to perform ozone modeling. Estimates of the amount of activity that will result from a proposed CPA lease sale was made using the scenarios for an individual typical lease sale and all cumulative OCS activities in the CPA (**Tables A-1 and A-2**). BOEM can attribute an amount of emissions generated by each activity through information collected in the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) and Rigzone (2009). A spreadsheet was developed based on the findings of this study (Billings et al., official communication, 2012). Using the level of activity and the activity's known emissions, total emissions were determined for each type of activity for each of the 40 years of the analysis period for a CPA proposed action.

Yearly emissions from all of these activities and sources were summed together and modeled: exploration and delineation drilling; development and production drilling; platform installation and removal; pipeline installation; production platform operations; tanker loading; tanker in transit; tanker unloading; and helicopters and support vessels. Drilling comprises approximately 60-75 percent of the total emissions. Emissions for the year with the highest annual emissions during the 40-year analysis period (tons/year) and the cumulative sum of all emissions from all OCS-related activities in the CPA during the 40-year analysis period (tons) are shown in **Tables A-2**. The data in the EIS spreadsheets were based on an average drillship as reported in Wilson et al. (2010) and Rigzone (2009) for the Gulf of Mexico. Drilling days and average kilowatts were used to calculate reasonably foreseeable emissions. Specific drillships can be significantly larger or smaller than the average value used in the spreadsheet and greater total emissions could be generated if the drillship stays on location longer. These averages may not, in every situation, directly translate to the short-term (as opposed to annual) NAAQS; nevertheless, BOEM's subject-matter experts believe that the analysis remains conservative with regards to reasonably foreseeable emissions expected to result from a CPA proposed action.

The single sale projected emissions were then assigned to a block within the CPA for OCD 5 modeling. Modeling emissions from cumulative sales was not performed because although the cumulative emissions are greater than the lease sale emissions, the emissions would be widely distributed across the planning areas and would be the result of activities based on all stages of the life of the lease. Since drilling is the activity with the greatest emissions and is most concentrated in a new lease, modeling for a single lease sale was considered sufficient. At the time of a CPA lease sale, BOEM can only generally predict where or when the activities that generate air pollutants will occur during the 40-year analysis period within the planning areas. Of the various types of drilling rigs, the drillship was chosen because it generates the greatest amount of emissions since it is not anchored to the seafloor. Instead, the drillship depends on engines to stay on location. Thus, the drillship's emissions result from both drilling and the thrusters used to maintain location. A drillship generates 773 tons of NO_x per well whereas a jack-up rig generates 47 tons of NO_x per well. The selected CPA source (Mississippi Canyon Block 856 [MC 856]) is about 56 miles (90 kilometers) from the closest shoreline and 95 miles (153 kilometers) from the Breton Class I area. All of the emissions from the year with the highest activity were placed in one location rather than distributed across the proposed CPA lease sale area. The modeling scenarios are presented in **Table A-3**.

The meteorological data used are described in BOEM's *Five-Year Meteorological Datasets for CALMET/CALPUFF and OCD5 Modeling of the Gulf of Mexico Region* (Douglas and Hudischewskyj, 2008). The meteorological files to use in the OCD 5 model were prepared using onshore surface and upper-air data from the National Weather Service, mixing height estimates obtained from the National Climatic Data Center, and offshore buoy data from the National Data Buoy Center (Douglas and Hudischewskyj, 2008). The meteorological data used were from the period 2000 through 2004. For MC 856, surface data come from Patterson, Louisiana, and upper air data come from Slidell, Louisiana. Buoy data for MC 856 come from Buoy 42040. These meteorological data points are the closest, physically, to the proposed lease sale area available to BOEM and, therefore, are the best approximation available.

The modeling domain was selected to include the closest shoreline area potentially impacted by emissions. Receptors were set at the Breton Class I area and the shoreline for the CPA. State's shoreline and the Breton Class I area were included. For the MC 856 source, 2 Florida, 3 Alabama, 3 Mississippi, 17 Louisiana, and 10 Breton Class I receptors were used.

Limitations

There are limitations associated with this modeling effort. The OCD 5 model was selected because it was specifically designed to include overwater conditions. The other models, which might have been selected, would possibly have included features such as the ability to determine ozone formation and the ability to model vessel emissions as a moving rather than stationary source. These models were not chosen because they are either not approved in USEPA's Appendix W or they do not reflect overwater conditions.

Furthermore, a more realistic estimation of shoreline impacts could have been obtained by distributing the sources of emissions across the OCS rather than using the assumption that all emissions occur at a single location in the CPA (MC 856). Results are not available for every point on the coast. The inclusion of more receptor locations would provide greater detail to the results. Modeling did not include every type of exploration and production activity or accidental event. Modeling did not include drilling at a location closer to shore with emissions representative of a more appropriate bottom-founded rig.

Nevertheless, by using a reasonable conservative approach, which includes the overestimation of reasonable emissions, and attribution of the source of these emissions to a single point in each of the proposed lease sale areas rather than at more dispersed source points throughout the proposed lease sale areas, and by using the conservative OCD 5 model, which is specifically designed to represent the offshore and coastal environment, the results of this modeling effort adequately represent a demonstration of the impacts of offshore emissions to the shoreline and to the Class I area.

OCD Model Results

The major pollutant emitted from a CPA proposed action is NO_x, while PM_{10} is the least emitted pollutant. Platform operations are contributors of VOC emissions. Commercial marine vessels are contributors of SO_2 and PM emissions. Support activities for OCS activities including crew and supply boats, helicopters, and pipeline vessels consist mainly of NO_x and CO emissions. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly to NO_x.

Since NO_x has the highest potential emissions for OCS activities, annual NO_2 and 1-hour NO_2 were analyzed and compared with the NAAQS. To be conservative, all emissions of NO_x were assumed to be equal to NO_2 for modeling purposes. Results are provided in **Table A-4** for the CPA Class I and Class II areas.

CPA

The results for the Class I (Breton National Wilderness) and Class II areas also demonstrate that a CPA proposed action's modeled impacts are below BOEM's Significance Levels and Maximum Allowable Increases, NAAQS, and the U.S. Environmental Protection Agency's SIL's for all the criteria pollutants except for the annual NO_x and the 24-hour $PM_{2.5}$. Although the SIL's were exceeded, BOEM expects in practice, if the emissions were distributed more realistically across the CPA, that emissions would not exceed the SIL; and thus, actual emissions likely to result from a CPA proposed action would likely not be significant. The modeling that was conducted was overly conservative. All the emissions during 1 year for the entire CPA, which would actually be dispersed throughout the CPA, were modeled as if they originated in Mississippi Canyon Block 856. BOEM is confident that the modeled impacts from OCS activity continue to support its conclusion that the proposed action will only minimally impact onshore air quality.

The results also indicate that the maximum modeled concentrations for the 1-hour averaging period for the NO_2 combined with the nearest representative onshore NO_2 monitored concentrations do not exceed the NO_2 1-hour NAAQS for the Breton National Wilderness Area as well as for the entire CPA (**Table A-4**). Although BOEM's regulations do not include a 1-hour NO_2 standard, BOEM modeled 1-hour NO_2 impacts from a CPA proposed action because the 1-hour standard is harder to meet than BOEM's annual NO_x maximum allowable increase. The results of the modeled impacts support the conclusion that there will be minimal impacts to onshore air quality.

Conclusion

Based on studies conducted in 1995, 2000, and 2008, BOEM has determined that OCS activities contributed only slightly to onshore ozone exceedances in the Houston/Brazoria/Galveston areas of Texas, and the States of Louisiana, Mississippi, Alabama, and Florida. Consequently, ozone modeling was not performed for this analysis. The OCD model was selected to model for the pollutants CO, NO_x, SO_x, $PM_{2.5}$, and PM_{10}. BOEM used a conservative approach in choosing and populating the OCD model for this analysis, which includes the overestimation of reasonable emissions and the attribution of the source of these emissions to a single point in each of the proposed lease sale areas rather than at more realistic source points throughout the proposed lease sale areas. The conservative OCD 5 model is specifically designed to represent the offshore and coastal environments. The results of this modeling effort adequately represent a demonstration of the impacts of offshore emissions to the shoreline and to the Class I area.

The OCD 5 modeling was performed for the CPA Class I area and the CPA Class II areas. The CPA hypothetical source location was chosen approximately 56 miles (90 kilometers) from shore. Even with all the emissions being attributed to a single point, which would not be the case in reality, CPA emissions would minimally impact onshore air quality. Significant impacts to air quality are not expected to result from a CPA proposed action.

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Table A-1

Central Planning Area – Estimate of High-Case Emissions for a Single Sale: Highest Year of Emissions during the 40-Year Period of Activity (tons/year)

	NO_x	SO_x	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	10,568.34	246.01	380.32	368.91	207.04	2,327.83	802,296.17	6.63	24.85
Development/Production Well Drilling	4,561.63	5.02	152.84	148.26	91.83	1,133.34	408,984.93	3.38	12.67
Platform Installation and Removal	216.56	2.73	7.42	7.20	3.17	57.68	17,257.87	0.10	0.79
Pipeline Installation	133.88	1.85	3.79	3.68	3.91	27.73	14,406.80	0.17	0.66
Production Platforms	3,157.65	43.40	33.16	32.69	2,576.37	3,491.76	357,786.08	17,940.43	5.32
Tankers Loading	0.14	0.02	0.0034	0.0031	31.51	0.0136	5.98	6.16E-05	0.0002
Tankers in Transit	5.08	0.60	0.12	0.11	0.58	0.50	221.61	0.0011	0.01
Tankers Unloading	0.14	0.01	0.0034	0.0031	9.68	0.0136	5.98	6.16E-05	0.0002
Helicopters	33.5310	8.2700	6.6166	6.6166	81.6128	408.83	41,353.82	0.00E+00	0.00E+00
Support Vessels	2,038.47	2.49	69.85	67.76	29.84	542.92	162,447.60	0.99	7.42
Total	20,715.42	310.41	654.13	635.23	3,035.54	7,990.61	1,804,766.85	17,951.70	51.71

CH4 – methane
CO – carbon monoxide
CO2 – carbon dioxide
N2O – nitrous oxide
NOx – nitrogen oxides
PM10 – particulate material less than 10µm in size
PM2.5 – particulate material less than 2.5µm in size
SOx – sulfur oxides
VOC – volatile organic compound

Table A-2

Central Planning Area – Estimate of High-Case Emissions for Cumulative Sales: Total Emissions during the 40-Year Period of Activity (tons)

	NO_x	SO_x	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	1,418,906.52	3,797.42	47,632.79	46,203.81	28,854.46	347,702.69	126,296,548.05	1,058.08	3,799.01
Development/Production Well Drilling	1,73,8078.63	2,390.40	58,097.52	56,354.60	35,394.37	428,711.63	156,091,192.49	1,307.67	4,694.93
Platform Installation and Removal	59,513.87	126.70	2,053.02	1,991.43	869.36	15,726.68	4,698,377.58	27.67	214.46
Pipeline Installation	60,497.90	177.59	1,728.99	1,677.12	1,770.85	12,456.98	6,432,426.19	75.80	293.74
Production Platforms	2,192,552.79	30,138.08	23,021.72	22,697.05	1,788,929.87	2,424,540.85	248,432,794.68	12,457,138.92	3,694.40
Tankers Loading	7.71	0.11	0.19	0.17	1,774.84	0.76	336.78	0.00	0.01
Tankers in Transit	285.97	4.01	7.02	6.43	32.81	28.31	12,484.17	0.06	0.50
Tankers Unloading	7.71	0.08	1.89E-01	1.73E-01	545.14	0.76	336.78	0.0035	0.0134
Helicopters	22,772.43	5,616.57	4.49E+03	4.49E+03	55,426.98	277,657.75	28,085,285.00	0.0000	0.00
Support Vessels	1,233,296.32	1,059.64	4.23E+04	4.10E+04	18,047.48	328,241.63	98,199,575.43	597.3796	4,482.4038
Total	6,725,919.86	43,310.60	179,321.24	174,442.00	1,931,646.16	3,835,068.04	668,249,357.14	12,460,205.60	17,179.46

CH4 – methane
CO – carbon monoxide
CO2 – carbon dioxide
N2O – nitrous oxide
NOx – nitrogen oxides
PM10 – particulate material less than 10µm in size
PM2.5 – particulate material less than 2.5µm in size
SOx – sulfur oxides
VOC – volatile organic compound

Table A-3

Modeling Scenarios

Modeling Scenarios	Source Location		Activity Represented	NO_x (g/sec)	SO_x (g/sec)	PM_{10} (g/sec)	$PM_{2.5}$ (g/sec)	VOC (g/sec)	CO (g/sec)
	Area	Area/ Block							
1	CPA	MC 856	All activity during the year with the highest lease sale emissions	595.9	8.9	18.8	18.3	87.3	229.9

CO – carbon monoxide
CPA – Central Planning Area
g/sec – grams per second
MC – Mississippi Canyon
NO_x – nitrogen oxides
PM_{10} – particulate material less than 10μm in size
$PM_{2.5}$ – particulate material less than 2.5μm in size
SO_x – sulfur oxides
VOC – volatile organic compound

Table A-4

OCD Modeling Results for a CPA Proposed Action Compared with USEPA's Significance Impact Levels and the NAAQS

Pollutant	Averaging Times	BOEM Significance Levels ($\mu g/m^3$)	BOEM Maximum Allowable Increases ($\mu g/m^3$)		NAAQS ($\mu g/m^3$)	USEPA PSD Significance Impact Levels ($\mu g/m^3$)		BOEM Modeled Impacts for the CPA ($\mu g/m^3$)	
			Class I	Class II		Class I	Class II	Class I	Class II
CO	8-hour	500	None	None	10,000	None	500	None	None
	1-hour	2,000	None	None	40,000	None	2,000	None	None
NO_2	Annual	1	None	None	100	0.1	1	0.4	0.6
	1-hour	None	None	None	188	TBD	7.5[a]	55.4[b]	177.67[c]
SO_2	Annual	1	2	20	80[d]	0.1	1	0.01	0.0
	24-hour	5	5	91	365[d]	0.2	5	0.1	0.2
	3-hour	25	2	512	1,300	1	25	0.5	0.5
	1-hour	None	None	None	196	TBD	7.86[a]	0.8	1.3
$PM_{2.5}$[e]	Annual	1	5	19	12	0.06	0.3	0.0	0.0
	24-hour	5	10	37	35	0.07	1.2	0.3	0.4
PM_{10}[e]	Annual					0.2	1	0.0	0.0
	24-hour					0.3	5	0.3	0.4

$\mu g/m^3$ – micrograms per cubic meter
BOEM – Bureau of Ocean Energy Management
CO – carbon monoxide
CPA – Central Planning Area
NAAQS – National Ambient Air Quality Standards
NO_2 – nitrogen dioxide
OCD – Offshore and Coastal Dispersion
PM_{10} – particulate material less than 10µm in size
$PM_{2.5}$ – particulate material less than 2.5µm in size
SO_x – sulfur oxides
TBD – to be determined
USEPA – U.S. Environmental Protection Agency

APPENDIX B

CATASTROPHIC SPILL EVENT ANALYSIS: HIGH-VOLUME, EXTENDED-DURATION OIL SPILL RESULTING FROM LOSS OF WELL CONTROL ON THE GULF OF MEXICO OUTER CONTINENTAL SHELF

TABLE OF CONTENTS

FIGURES

TABLES

B. CATASTROPHIC SPILL EVENT ANALYSIS: HIGH-VOLUME, EXTENDED-DURATION OIL SPILL RESULTING FROM LOSS OF WELL CONTROL ON THE GULF OF MEXICO OUTER CONTINENTAL SHELF

B.1. INTRODUCTION

In 1986, the Council on Environmental Quality (CEQ) regulations were amended to rescind the requirement to prepare a "worst-case analysis" for an environmental impact statement (EIS) (refer to 40 CFR § 1502.22(b)(4)). The regulation, as amended, states that catastrophic, low-probability impacts must be analyzed if the analysis is "supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason."

The August 16, 2010, CEQ report, prepared following the *Deepwater Horizon* explosion, oil spill, and response in the Gulf of Mexico, recommended that the Bureau of Ocean Energy Management (BOEM), formerly the Minerals Management Service (MMS) and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), should "ensure that National Environmental Policy Act (NEPA) documents provide decisionmakers with a robust analysis of reasonably foreseeable impacts, including an analysis of reasonably foreseeable impacts associated with low-probability catastrophic spills for oil and gas activities on the Outer Continental Shelf" (CEQ, 2010). This evaluation is a robust analysis of the impacts from low-probability catastrophic spills and will be made available to all applicable decisionmakers including, but not limited to, the Secretary of the Department of the Interior (USDOI) for the National Five-Year Program, the Assistant Secretary of Land and Minerals Management for an oil and gas lease sale, and the Regional Supervisors of the Gulf of Mexico OCS Region's Office of Environment and Office of Leasing and Plans.

It should be noted that the analysis presented here is intended to be a general overview of the potential effects of a catastrophic spill in the Gulf of Mexico. As such, the *Catastrophic Spill Event Analysis* should be read with the understanding that further detail about accidental oil impacts on a particular resource may be found in the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2015-2017 Central Planning Area Lease Sales 235, 241, and 247, Draft Supplemental Environmental Impact Statement (CPA 235, 241, and 247 Supplemental EIS)* analysis or previous relevant NEPA analyses (e.g., the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247, Final Environmental Impact Statement* [2012-2017 WPA/CPA Multisale EIS]; USDOI, BOEM, 2012; the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Final Supplemental Environmental Impact Statement* [WPA 233/CPA 231 Supplemental EIS]; USDOI, BOEM, 2013a; and the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2014 and 2016, Eastern Planning Area Lease Sales 225 and 226, Final Environmental Impact Statement* [EPA 225/226 EIS]; USDOI, BOEM, 2013b).

B.1.1. What is a Catastrophic Event?

As applicable to NEPA, Eccleston (2008) defines a catastrophic event as "large-scale damage involving destruction of species, ecosystems, infrastructure, or property with long-term effects, and/or major loss of human life." For oil and gas activities on the Outer Continental Shelf (OCS), a catastrophic event is a high-volume, extended-duration oil spill regardless of the cause, whether natural disaster (i.e., hurricane) or manmade (i.e., human error and terrorism). This high-volume, extended-duration oil spill, or catastrophic spill, has been further defined by the National Oil and Hazardous Substances Pollution Contingency Plan as a "spill of national significance" or "a spill which, because of its severity, size, location, actual or potential impact on the public health and welfare or the environment, or the necessary response effort, is so complex that it requires extraordinary coordination of federal, state, local, and responsible party resources to contain and cleanup the discharge" (40 CFR part 300, Appendix E).

Each oil-spill event is unique; its outcome depends on several factors, including time of year and location of release relative to winds, currents, land, and sensitive resources; specifics of the well (i.e., flow rates, hydrocarbon characteristics, and infrastructure damage); and response effort (i.e., speed and effectiveness). For this reason, the severity of impacts from an oil spill cannot be predicted based on volume alone, although a minimum volume of oil must be spilled to reach catastrophic impacts.

Though large spills may result from a pipeline rupture, such events will not result in a catastrophic spill because the ability to detect leaks and shut off pipelines limits the amount of the spill to the contents of the pipeline. The largest, non-blowout-related spill on the Gulf of Mexico OCS occurred in 1967, a result of internal pipeline corrosion following initial damage by an anchor. In 13 days, 160,638 barrels (bbl) of oil leaked (USDOI, BSEE, 2012); however, no significant environmental impacts were recorded as a result of this spill.

Although loss of well control is defined as the uncontrolled flow of reservoir fluid that may result in the release of gas, condensate, oil, drilling fluids, sand, or water, it is a broad term that includes very minor well control incidents as well as the most severe well control incidents. Historically, loss of well control incidents occurred during development drilling operations, but loss of well control incidents can occur during exploratory drilling, production, well completions, or workover operations. These losses of well control incidents may occur between formations penetrated in the wellbore or at the seafloor.

Prior to the *Deepwater Horizon* explosion, oil spill, and response, the two largest spills resulting from a loss of well control in U.S. waters of the Gulf of Mexico occurred in 1970 and released 30,000 and 53,000 bbl of oil, respectively (USDOI, BSEE, 2012). These incidents resulted in four human fatalities. Although these incidents occurred only 8-14 miles (mi) (13-26 kilometers [km]) from shore, there was minor shoreline contact with oil (USDOC, NOAA, Office of Response and Restoration, 2010a and 2010b). In 1987, a blowout of the Mexican exploratory oil well, YUM II, resulted in a spill of 58,640 bbl and 75 mi (121 km) of impacted shoreline (USDOC, NOAA, Hazardous Materials Response and Assessment Division, 1992). However, none of these spills met the previously described definitions of a catastrophic event or spill.

A blowout is a more severe loss of well control incident that creates a greater risk of a large oil spill and serious human injury. Two blowouts that resulted in catastrophic spills have occurred in U.S. and Mexican waters of the Gulf of Mexico. On June 3, 1979, the *Ixtoc I* well blowout in shallow water (water depth of 164 feet [ft] [50 meters [m]] and 50 mi [80 km] offshore in the Bay of Campeche, Mexico) spilled 3.5 million barrels (MMbbl) of oil in 10 months (USDOC, NOAA, Office of Response and Restoration, 2010c; USDOC, NOAA, Hazardous Materials Response and Assessment Division, 1992; ERCO, 1982). On April 20, 2010, the *Macondo* well blowout (*Deepwater Horizon* explosion, oil spill, and response) in deep water (4,992 ft; 1,522 m) 48 mi (77 km) offshore in Mississippi Canyon Block 252, spilled an estimated 4.9 MMbbl of oil until it was capped approximately 3 months later. Due to being classified as catastrophic, the *Ixtoc I* and *Macondo* well blowouts and spills were utilized to develop the catastrophic spill event scenario in this analysis.

B.1.2. Methodology

Two general approaches are utilized to analyze a catastrophic event under NEPA. The first approach is a bounding analysis for each individual resource category (e.g., marine mammals and sea turtles). A bounding analysis involves selecting and evaluating a different set of factors and scenarios for each resource in the context of a worst-case analysis. The second approach involves the selection of a single set of key circumstances that, when combined, result in catastrophic consequences. The second approach is used for a site-specific analysis and, consequently, its possible application is more limited. Accordingly, this analysis combines the two approaches, relying on a generalized scenario while identifying site-specific severity factors for individual resources. This combined approach allows for the scientific investigation of a range of possible, although not necessarily probable, consequences of a catastrophic blowout and oil spill in the Gulf of Mexico.

B.1.2.1. Geographic Scope

The Gulf of Mexico is a semi-enclosed basin with an extensive history of oil and gas activities and unique environmental conditions and hydrocarbon reservoir properties; consequently, this analysis is only applicable to the Gulf of Mexico OCS and is not intended for other OCS regions.

B.1.2.2. Impact-Producing Factors and Scenario

A hypothetical, yet feasible, scenario (**Chapter B.2**) was developed to provide a framework for identifying the impacts of an extended oil spill from an uncontrolled blowout. Unless noted, this scenario is based on the large magnitude, blowout-related oil spills that have occurred in the Gulf of Mexico, i.e., *Ixtoc I* and *Macondo* well blowouts and spills (discussed in **Chapter B.1.1**). As noted above, because each spill event is unique, its outcome depends on many factors. Therefore, the specific impacts from future spills cannot be predicted based on this scenario.

B.1.2.3. OSRA Catastrophic Run

A special Oil-Spill Risk Analysis (OSRA) model run was conducted to estimate the impacts of a possible future catastrophic or high-volume, extended-duration oil spill. This analysis emphasized modeling a spill that continued for 90 consecutive days by launching spills on each of 90 consecutive days, with each trajectory tracked for up to 60 days. The OSRA was conducted for only the trajectories of oil spills from hypothetical spill locations to various onshore and offshore environmental resources. Though this Appendix is associated with all three planning areas, data from three hypothetical spill locations located in the Central Planning Area (CPA) (**Figure B-1**) were included and are intended for use as examples of this type of exercise. Information on previous catastrophic OSRA runs for the CPA can be found in **Appendix C** of this Supplemental EIS and in Appendix C of the 2012-2017 WPA/CPA Multisale EIS.

The probability of an oil spill contacting a specific resource within a given time of travel from a spill point is termed a conditional probability; the condition being that a spill is assumed to have occurred. Each trajectory was allowed to continue for as long as 60 days. However, if the hypothetical spill contacted shoreline sooner than 30 days after the start of the spill, the spill trajectory was terminated, and the contact was recorded. Although, overall OSRA is designed for use as a risk-based assessment, for this analysis, only the conditional probability, the probability of contact to the resource, was calculated. The probability of a catastrophic spill occurring was not calculated; thus, the combination of the probability of a spill and the probability of contact to the resources from the hypothetical spill locations were not calculated. Results from this trajectory analysis provide input to the final product by estimating where spills might travel on the ocean's surface and what environmental resources might be contacted if and when another catastrophic spill occurs, but it does not provide input on the probability of another catastrophic spill occurring. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

B.1.2.4. Environmental and Socioeconomic Impacts

This analysis evaluates the impacts to the Gulf of Mexico's biological, physical, and socioeconomic resources from a catastrophic blowout, oil spill, and associated cleanup activities.

Although the most recent EIS's prepared by this Agency for oil and gas lease sales in the Gulf of Mexico analyze the potential impacts from smaller oil spills that are more reasonably foreseeable (USDOI, MMS, 2007 and 2008), this analysis focuses on the most likely and most significant impacts created by a high-volume, extended-duration spill. Because catastrophic consequences may not occur for all resources, factors affecting the severity of impacts are identified by the individual resource.

B.1.3. How to Use This Analysis

The purpose of this technical analysis is to assist BOEM in meeting CEQ requirements that require a discussion of impacts from catastrophic events. This analysis, based on credible scientific evidence, identifies the most likely and most significant impacts from a high-volume blowout and oil spill that continues for an extended period of time. The scenario and impacts discussed in **Chapters B.2 and B.3** should not be confused with the scenario and impacts anticipated to result from routine activities or the more reasonably foreseeable accidental events of a CPA proposed action.

Chapter B.2 is intended to clearly describe the scenario presented for all four phases of a catastrophic blowout event and identify the impact-producing factors associated with each phase. **Chapter B.3** is intended to analyze the impacts of each phase of a catastrophic blowout on various environmental resources. These chapters can be used to differentiate the conditions of a catastrophic spill from the routine activities and accidental events described in this Supplemental EIS.

This technical analysis is designed to be incorporated by reference in future NEPA documents and consultations. Therefore, factors that affect the severity of impacts of a high-volume, extended-duration spill on individual resources are highlighted for use in subsequent site-specific analyses.

To analyze a hypothetical catastrophic event in an area such as the Gulf of Mexico, several assumptions and generalizations were made. However, future project-specific analyses should also consider specific details such as potential flow rates for the specific proposed activity, the properties of the targeted reservoir, and the proximity to environmental resources of the proposed activities.

B.2. Impact-Producing Factors and Scenario (Phases 1-4)

For the purposes of this analysis, an event similar to the *Ixtoc I* well blowout and spill that occurred in 1979 in 160-ft (50-m) water depth will be used as the basis for a shallow water spill and an event similar to the *Macondo* well blowout and spill that occurred in 2010 in the Mississippi Canyon area in 5,000-ft (1,524-m) water depth will be used to represent a deepwater spill.

B.2.1. Phase 1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout incident. While most of the environmental and socioeconomic impacts of a catastrophic blowout would occur during the ensuing high-volume, extended-duration spill (refer to **Chapter B.3**), it is important to acknowledge the deadly events that could occur in the initial phase of a catastrophic blowout. The following scenario was developed to provide a framework for identifying the most likely and most significant impacts during the initial phase.

Impacts, response, and intervention depend on the spatial location of the blowout and release. While there are several points where a blowout could occur, four major distinctions that are important to the analysis of impacts are described in **Table B-1**.

For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, a fire could result that would burn for 1 or 2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month (USDOC, NOAA, Office of Response and Restoration, 2010b). The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. For example, when the drilling rig *Deepwater Horizon* sank, it landed 1,500 ft (457 m) away on the seafloor. Regardless of water depth, the immediate response would be from search and rescue vessels and aircraft, such as United States Coast Guard (USCG) cutters, helicopters, and rescue planes.

B.2.2. Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters.

B.2.2.1. Duration of Spill

The duration of the offshore spill from a blowout depends on the time needed for intervention and the time the remaining oil persists offshore. If a blowout occurs and the damaged surface facilities preclude well reentry operations, a relief well may be needed to regain control. The time required to drill the relief well depends on the complexity of the intervention, the location of a suitable rig, the type of operation that must be terminated to release the rig (e.g., casing may need to be run before releasing the rig), and the logistics in mobilizing personnel and equipment to the location. A blown-out well may also be successfully capped prior to completion of relief wells, as occurred in the *Macondo* well blowout. In terms of persistence of spilled oil on surface waters, oil from the *Macondo* well blowout did not persist for more than 30 days (OSAT, 2010). However, based on BOEM's weathering modeling (refer to **Appendix C**), it is assumed that oil could persist on surface waters for as long as 1-2 months, depending on the season and year.

B.2.2.1.1. Shallow Water

If a blowout occurs in shallow water, it is estimated that the entire well intervention effort including drilling relief wells, if deemed necessary, could take 1-3 months. This estimate would include 1-3 weeks to transport the drilling rig to the well site. Spilled surface oil is not expected to persist more than 1-2 months (depending upon the season and environmental conditions) after the flow is stopped. Spilled oil is more likely to persist in the offshore environment during colder weather and during wind and hydrodynamic conditions that keep the oil offshore. Therefore, the estimated spill duration resulting from a shallow water blowout is 2-5 months (approximately 1-3 months for active spillage and 1-2 months for oil persistence in the environment).

B.2.2.1.2. Deep Water

If a blowout occurs in deep water, it is estimated that it would take 2-4 weeks to remove debris and to install a capping stack or a cap and flow system on a well, if conditions allow this type of intervention. The entire intervention effort including drilling relief wells, if deemed necessary, could take 3-4 months (USDOI, MMS, 2000; Regg, 2000). This includes 2-4 weeks to transport the drilling rig to the well site. Spilled surface oil is not expected to persist more than 1-2 months (depending upon the season and environmental conditions) after the flow is stopped. Spilled oil is more likely to persist in the offshore environment during colder weather and during wind and hydrodynamic conditions that keep the oil offshore. Therefore, the estimated spill duration from a deepwater blowout is 2-6 months (approximately 1-4 months for active spillage and 1-2 months for oil persistence in the environment).

B.2.2.2. Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of spreading depends on the type and volume of oil that is spilled. However, a catastrophic spill would likely spread to hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area.

Subsurface oil observed during both the *Ixtoc I* and *Macondo* well blowouts and spills could also spread to significant distances depending on environmental conditions (such as hydrodynamics), oil chemistry and weathering, and the application of subsea dispersants or mechanical conditions at the release point that would diffuse the oil.

B.2.2.3. Volume of Spill

After 50 years of oil and gas exploration and development activity on the continental shelf of the Gulf of Mexico in the CPA and WPA, most of the largest oil and natural gas reservoirs thought to exist in shallow water areas of the GOM at drill depths less than 15,000 ft (4,572 m) subsea have been identified. Large undiscovered hydrocarbon reservoirs are still thought to exist in the shallow water areas of the CPA and WPA. However, results taken from BOEM’s most recent resource assessment study and a review of the more recent shallow-water drilling and leasing activity suggest that future discoveries of large reservoirs in the shallow-water areas of the GOM are likely to exist greater than 15,000 ft (4,572 m) below sea level where geologic conditions are more favorable for natural gas reservoirs to exist than oil reservoirs. In contrast to the shallow-water areas of the GOM where the discovery of a new, large, prolific oil reservoir is considered a low-probability event, the results from BOEM’s resource assessment study pertaining to the deeper water areas of the GOM suggest that there is a high probability that many large oil and gas reservoirs have yet to be discovered in deep water. BOEM’s forecast for deep water has support from other public and private sector resource studies. The forecast is also supported by the results of BOEM’s analysis of deepwater leasing and drilling activity, which indicates that the industry is leasing acreage in deepwater areas of the GOM where large prospects can be identified and where the majority of exploration and development drilling activity targets potentially thick oil reservoirs capable of achieving the high production rates necessary to offset the high costs associated with deep water oil development in the GOM.

B.2.2.3.1. Shallow Water

For this analysis, an uncontrolled flow rate of 30,000 bbl per day is assumed for a catastrophic blowout in shallow water. This assumption is based upon the results of well tests in shallow water and the maximum flow rate from the 1979 *Ixtoc I* well blowout, which occurred in shallow water. Using this flow rate, the total volume of oil spilled from a catastrophic blowout in shallow water is estimated at 900,000 bbl to 3 MMbbl from spillage occurring over 1-3 months. In addition to the flow rate, it is assumed that any remaining diesel fuel from a sunken drilling rig or platform would also leak.

B.2.2.3.2. Deep Water

For the purposes of this analysis, an uncontrolled flow rate of 30,000-60,000 bbl per day is assumed for a catastrophic blowout in deep water. This flow rate is based on the assumption in **Chapter B.2.2.3.1** above, well test results, and the maximum flow rate estimated for the *Macondo* well blowout and spill, which occurred in deep water. Therefore, the total volume of oil spilled is estimated to be 0.9-7.2 MMbbl over 1-4 months. In addition, deepwater drilling rigs or platforms hold a large amount of diesel fuel (10,000-20,000 bbl). Therefore, it is assumed that any remaining diesel fuel from a sunken structure would also leak and add to the spill.

B.2.2.4. Oil in the Environment: Properties and Persistence

The fate of oil in the environment depends on many factors, such as the source and composition of the oil, as well as its persistence (NRC, 2003). Persistence can be defined and measured in different ways (Davis et al., 2004), but the National Research Council (NRC) generally defines persistence as how long oil remains in the environment (NRC, 2003; page 89). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (NRC, 2003). These processes may interact and affect the properties and persistence of the oil through the following:

- evaporation (volatilization);
- emulsification (the formation of a mousse);
- dissolution;
- oxidation (including respiration); and
- transport processes (NRC, 2003; Scholz et al., 1999).

Horizontal transport takes place via spreading, advection, dispersion, and entrainment while vertical transport takes place via dispersion, entrainment, Langmuir circulation, sinking, overwashing, partitioning, and sedimentation (NRC, 2003). The persistence of an oil slick is influenced by the effectiveness of oil-spill response efforts and affects the resources needed for oil recovery (Davis et al., 2004). The persistence of an oil slick may also affect the severity of environmental impacts as a result of the spilled oil.

Crude oils are not a single chemical, but instead are complex mixtures with varied compositions. Thus, the behavior of the oil and the risk the oil poses to natural resources depends on the composition of the specific oil encountered (Michel, 1992). Generally, oils can be divided into three groups of compounds: (1) light-weight; (2) medium-weight; and (3) heavy-weight components. On average, these groups are characterized as outlined in **Table B-2**.

Of the oil reservoirs sampled in the Gulf of Mexico OCS, the majority fall within the light-weight category, while less than one quarter are considered medium-weight and a small portion are considered heavy-weight. Oil with an API gravity of 10.0 or less would sink and has not been encountered in the Gulf of Mexico OCS; therefore, it is not analyzed in this Appendix (USDOI, BOEMRE, 2010a).

Heavy-weight oil may persist in the environment longer than the other two types of oil, but the medium-weight components within oil present the greatest risks to organisms because, with the exception of the alkanes, these medium-weight components are persistent, bioavailable, and toxic (Michel, 1992).

Previous studies (e.g., Johansen et al., 2001) supported the theory that most, if not all, released oil would reach the surface of the water column. However, data and observations from the *Macondo* well blowout and spill challenge that theory. While analyses are in their preliminary stages, it appears that measurable amounts of hydrocarbons (dispersed or otherwise) were detected in the water column as subsurface "plumes" and on the seafloor in the vicinity of the release. While not all of these hydrocarbons have been definitively traced back to releases from the *Macondo* well, these early measurements and results warrant a reassessment of previous theories of the ultimate fate of hydrocarbons from unintended subsurface releases. It is important to note that the North Sea experiment (Johansen et al., 2001) did not include the use of dispersants at or near the source of the subsea oil discharge.

B.2.2.5. Release of Natural Gas

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 (NaturalGas.org, 2012). Thus, if natural gas were to leak into the environment, methane may be released into the environment. Limited research is available for the biogeochemistry of hydrocarbon gases in the marine environment (Patin, 1999, page 233). Theoretically, methane could stay in the marine environment for long periods of time (Patin, 1999, page 237) as methane is highly soluble in seawater at the high pressures and cold temperatures found in deepwater environments (NRC, 2003, page 108). Methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974, page 23). Methane is a carbon source and its introduction into the marine environment could result in diminished dissolved oxygen concentrations due to microbial degradation.

The *Macondo* well blowout and spill resulted in the emission of an estimated 9.14×10^9 to 1.29×10^{10} moles of methane from the wellhead (Kessler et al., 2011; Valentine et al., 2010) with maximum subsurface methane concentrations of 183-315 micromoles measured in May/June 2010 (Valentine et al., 2010; Joye et al., 2011). This methane release corresponded to a measurable decrease in oxygen in the subsurface plume due to respiration by a community of methanotrophic bacteria. During the *Macondo* well blowout and spill, methane and oxygen distributions were measured at 207 stations throughout the affected region (Kessler et al., 2011). Based on these measurements, it was concluded that within ~120 days from the onset of release ~3.0×10^{10} to 3.9×10^{10} moles of oxygen were respired, primarily by methanotrophs, and left behind a residual microbial community containing methanotrophic bacteria. The researchers further suggested that a vigorous deepwater bacterial bloom respired nearly all the released methane within this time and that by analogy, large-scale releases of methane from hydrates in the deep ocean are likely to be met by a similarly rapid methanotrophic response. However, hypoxic conditions were never reached (OSAT, 2010). Hypoxic conditions are generally agreed to occur when dissolved oxygen falls below 2 milligrams/liter (1.4 milliliter/liter) (OSAT, 2010). Note that methane released from the *Macondo* well blowout and spill was generally confined to the subsurface, with minimal amounts reaching the atmosphere (Kessler et al., 2011; Ryerson et al., 2011).

B.2.2.6. Deepwater Subsea Containment

To address the new improved containment systems' expectations to rapidly contain a spill as a result of a loss of well control from a subsea well as addressed in Notice to Lessees and Operators (NTL) 2010-N10, the Marine Well Containment Company (MWCC) and Helix Well Containment Group (HWCG) initiated the development of new, rapid response systems. These systems are designed to fully contain oil flow in the event of a potential future underwater blowout and to address a variety of scenarios. The systems consist of specially designed equipment constructed, tested, and available for rapid response. Both the MWCC and the HWCG systems are anticipated to be fully operational within days to weeks after a spill event occurs. The availability of these systems can significantly reduce the length of time a blowout continues, thereby reducing the amount of oil potentially spilled during a catastrophic spill. However, this assumes that a particular blowout situation lends itself to the use of this subsea containment technology, whereas there are some situations that may delay or make its use improbable, such as the location of debris resulting from the blowout and the condition of the well.

The MWCC system is designed to operate in up to a 10,000-ft (3,048-m) water depth and adds containment capability of 60,000 bbl of oil per day. The HWCG system focuses on the utilization of the *Helix Producer I* and the *Q4000* vessels. Each of these vessels played a role in the *Macondo* well blowout and spill response, and each of these vessels are continually working in the Gulf. The HWCG system has the ability to fully operate in up to 10,000 ft (3,048 m) of water and has intervention equipment to cap and contain a well with the mechanical integrity to be shut-in. The HWCG system also has the ability to capture and process 55,000 bbl of oil per day (Helix Well Containment Group, 2010).

In addition, industry has a multitude of vendors available within the GOM region that can provide the services and supplies necessary for debris removal capability, dispersant injection capability, and top-hat deployment capability. Many of these vendors are already cited for use by MWCC and HWCG.

The BSEE has indicated to BOEM that, it will not allow an operator to begin drilling operations until adequate subsea containment and collection equipment, as well as subsea dispersant capability is determined by BSEE to be available to the operator and is sufficient for use in response to a potential incident from the proposed well(s) (refer to NTL 2010-N10). The BSEE conducted a successful deployment drill of Helix's subsea containment capping stack in July 2012. A deployment drill of Helix's subsea containment capability is presently being planned by BSEE.

B.2.2.7. Offshore Cleanup Activities

As demonstrated by the *Ixtoc I* and *Macondo* well blowouts and spills, a large-scale response effort is certain to follow a catastrophic blowout. The number of vessels and responders would steadily increase as the spill continued. In the event of a spill, particularly a loss of well control, there is no single method of containment and removal that would be 100 percent effective. Removal and containment efforts to respond to an ongoing spill offshore would likely require multiple technologies, including source containment, mechanical cleanup, in-situ burning of the slick, and chemical dispersants. Even with the deployment of all of these spill-response technologies, it is likely that, with the operating limitations of today's spill-response technology, not all of the oil could be contained and removed offshore.

B.2.2.7.1. Shallow Water

The following are estimates for the deployment of equipment and personnel during a shallow-water spill response. Within the first week of an oil spill originating in shallow water, 25 vessels are estimated to respond, which would steadily increase to over 3,000 by the end of the spill. This includes about 25 skimmers in the vicinity of the well at any given time. In addition, recovered oil may be barged to shore from recovery vessels. Within the first week, over 500 responders are estimated to be deployed to a spill originating in shallow water, which would steadily increase up to 25,000 before the well is capped or killed within 2-4 months. Up to 25 planes and 50 helicopters are estimated to respond per day by the end of a shallow-water spill. Response to an oil spill in shallow water is expected to involve over 10,000 ft (3,048 m) of boom within the first week and would steadily increase up to 5 million feet (~950 mi; ~1,520 km) for use offshore and nearshore; the amount is dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities.

Dispersant use must be in accordance with the Regional Response Team's (RRT) Preapproved Dispersant Use Manual and with any conditions outlined within an RRT's 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, and monitoring requirements. At this time, this manual does not give preapproval for the application of dispersant use subsea. Aerial dispersants would likely be applied from airplanes as a mist, which settles on the oil on the water's surface. Along the Gulf Coast, surface dispersants are presently preapproved for use greater than 3 nautical miles (nmi) (3.5 mi; 5.6 km) from shore and in water depths greater than 33 ft (10 m), with the exception of Florida (U.S. Dept. of Homeland Security, CG, 2010). At this time, pursuant to a letter from the Florida Department of Environmental Protection dated May 5, 2011, sent to USCG, preapproval for dispersant use is not approved for any Florida State waters. However, USEPA is presently revisiting these RRT preapprovals in light of the dispersant issues, such as subsea application that arose during the *Macondo* well blowout and spill response. In addition, revisions are presently being made to the RRT IV and VI's Preapproved Dispersant Use Manuals. The USEPA issued a letter dated December 2, 2010, that provided interim guidance on the use of dispersants for major spills that are continuous and uncontrollable for periods greater than 7 days and for expedited approval of subsurface applications. This letter outlined the following exceptions to the current preapprovals until they are updated:

- dispersants may not be applied to major spills that are continuous in nature and uncontrollable for a period greater than 7 days;
- additional dispersant monitoring protocols and sampling plans may be developed that meet the unique needs of the incident; and
- subsurface dispersants may be approved on an incident-specific basis as requested by the USCG On-Scene Commander.

More robust documentation of dispersant usage may be required. This documentation would include daily reports that contain the products used, the specific time and locations of application, equipment used for each application, spotter aircraft reports, photographs, vessel data, and analytical data. In addition to dispersants, controlled burns may also occur. It is estimated that 5-10 controlled burns would be conducted per day in suitable weather. About 500 burns in all would remove 5-10 percent of the oil.

B.2.2.7.2. Deep Water

The following are estimates for the deployment of equipment and personnel during a deepwater spill response. Within the first week of an oil spill originating in deep water, 50 vessels are estimated to respond, which would steadily increase to over 7,000 by the end of the spill. This includes about 25 skimmers in the vicinity of the well at a time. In addition, recovered oil may be shuttle tankered to shore from recovery vessels. For an oil spill in deep water, over 1,000 responders are estimated to be deployed within the first week, which would steadily increase up to 50,000 before capping or killing the well within 4-5 months. Over 20,000 ft (6,096 m) of boom is estimated to be deployed within the first week of a deepwater spill, which would steadily increase up to 11 million feet (~2,100 mi; ~3,350 km) offshore and nearshore. The amount of boom would be dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. Up to 50 planes and 100 helicopters are estimated to respond per day by the end of a deepwater spill.

With the exception of special Federal management areas or designated exclusion areas, dispersants have been preapproved in the vicinity of a deepwater blowout (U.S. Dept. of Homeland Security, CG, 2010). However, USEPA is presently examining these preapprovals, and restrictions are anticipated regarding the future use of dispersants as a result. No preapproval presently exists for the use of subsea dispersants, and approval must be obtained before each use of this technology. The use of subsea dispersants depends on the location of the blowout, as discussed in **Table B-1**. Aerial dispersants are usually applied from airplanes as a mist, which settles on the oil on the water's surface. Major spills that are continuous and uncontrollable for periods greater than 7 days and the approval of subsurface dispersant application are presently subject to the guidance outlined in USEPA's letter dated December 2, 2010. This letter provides interim guidance on the use of dispersants for major spills and outlines exceptions to the current preapprovals until they are updated, as discussed more fully in **Chapter B.2.2.7.1**. For a deepwater spill, 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. However, the window of opportunity for successful dispersant application may be somewhat narrower for some deepwater locations depending on the physical and chemical properties of the oil, which tend to be somewhat heavier or more likely to emulsify than those found closer to shore. A significant reduction in the window of opportunity for dispersant application may render this response option ineffective.

In addition to dispersants, controlled burns may also occur. It is estimated that 5-10 controlled burns would be conducted per day in suitable weather. About 500 burns in all would remove 5-10 percent of the oil.

B.2.2.7.3. Vessel Decontamination Stations

To avoid contaminating inland waterways, multiple vessel decontamination stations may be established offshore in Federal and State waters. The selected locations to conduct decontamination of oiled vessels will, due to the unique aspects of each spill response, be decided by the Unified Command during the spill response effort. Since the Unified Command includes representatives of the affected state(s), the states will have a prominent voice regarding whether a location in State waters will be acceptable.

Vessels responding to the spill and commercial and recreational vessels passing through the spill would anchor, awaiting inspection. If decontamination is required, work boats would use fire hoses to clean oil from the sides of the vessels. This could result in some oiling of otherwise uncontaminated waters. While these anchorage areas would be surveyed for buried pipelines that could be ruptured by ship anchors, they may not be surveyed adequately for benthic communities or archaeological sites. Therefore, some damage to benthic communities or archaeological sites may occur because of vessel decontamination activities associated with an oil spill (Alabama State Port Authority, 2010; State of Florida, Office of the Governor, 2010; Nodar, 2010; Unified Incident Command, 2010a-c; USDOC, NOAA, 2010a; USEPA, 2012).

B.2.2.8. Severe Weather

A hurricane could accelerate biodegradation, increase the area affected by the spill, and slow or stop the response effort. The movement of oil would depend on the track, wind speed, and size of a hurricane. The official Atlantic hurricane season runs from June 1st through November 30th, with a peak of hurricane probability in September. In an average Atlantic season, there are 11 named storms, 6 hurricanes, and 2 Category 3 or higher storms (USDOC, NOAA, National Weather Service, 2010). As a result of a hurricane, high winds and seas would mix and weather the oil from an oil spill. This can help accelerate the biodegradation process (USDOC, NOAA, National Weather Service, 2012). The high winds may distribute oil over a wider area (USDOC, NOAA, National Weather Service, 2012).

Weather has been recognized as one of the most important factors in predicting oil-spill fate and behavior and in predicting the success of an oil-spill response. During an oil spill, booms, skimmers, oil burn, and the use of dispersants have been used to remove oil from the water surface. Adverse weather conditions will affect the use, performance and effectiveness of booms and skimmers. Skimmers work best in calm wind; for wave heights greater than 1 m (3 ft), some skimmers will not work effectively. Conventional booms will not work at a current velocity of 0.5 meters per second (m/sec) (1.6 feet per second [ft/sec]) or greater. For oil burn, ignition cannot be carried out at wind speeds greater than 10 m/sec (33 ft/sec). The minimum wind speed for dispersant use is about 5 m/sec (16 ft/sec), and the maximum wind speed for the limit of dispersant applications is about 12-14 m/sec (39-46 ft/sec) (Fingas, 2004).

There are tradeoffs in deciding where and when to place boom because, once deployed, boom is time consuming to tend and to relocate. As previously noted, booming operations are sensitive to wind, wave, and currents, and those sections of boom need to be tethered and secured to keep them from moving. Furthermore, it was discovered during the *Deepwater Horizon* explosion, oil spill, and response that hard boom often did more damage than anticipated in the marsh it was intended to protect after weather conditions ended up stranding the boom back into the marsh. Due to time constraints prior to a hurricane event, it is therefore unlikely that much effort could be expended to move large amounts of deployed boom, particularly given the effort that would be required to move skimming equipment to safer locations inland and to move large numbers of response personnel to safer areas. However, since the conditions for each spill response are unique, these considerations would be examined and a site-specific hurricane response plan developed during the actual spill response effort by the Unified Command at the beginning of the official hurricane season.

In addition, adverse weather would reduce ability to respond to the spill and could result in delayed transport and placement of the capping stack. The action of wind on the water surface will generate waves. Typically, waves greater than 3 ft (1 m) will prevent smaller vessels from skimming in offshore waters; waves greater than 5 ft (1.5 m) will prevent even the larger vessels from getting offshore to skim. The new high-speed skimmers under development are very promising; some skimmers have recovered oil with wave heights of up to 10 ft (3 m) with corresponding winds of up to 15 m/sec (49 ft/sec).

In the event of a hurricane, vessels would evacuate the area, delaying response efforts, including the drilling of relief wells and any well capping or collection efforts. Severe weather, such as a hurricane, would delay the transport and placement of the capping stack. If a cap is applied and oil is flowed to a collection vessel, severe weather would cause the collection vessel to vacate its location and the oil would flow until the collection vessel could return and resume collection. Severe weather could also require that response assets be relocated inland. The response would be delayed because following the severe weather event the assets would need to be transported back to the staging areas. The speed with which the assets could be brought back to the locations would depend upon on the condition of the roads and bridges for traffic resumption and the amount of debris potentially blocking the roads.

B.2.3. Phase 3—Onshore Contact

B.2.3.1. Duration

The duration of shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. The time needed to cap or kill a well may vary, depending on, among other things, the well's water depth, its location, the well and geologic formation characteristics, and the associated debris. Depending on the spill's location in relation to winds and currents and the well's distance to shore, oil could reach the coast within 1 week to 1 month, based on evidence from previous spills in the Gulf of Mexico OCS (e.g., it was nearly 4 weeks after the *Macondo* well blowout and spill). While it is assumed that the majority of spilled oil would dissipate offshore within 30-60 days of stopping the flow, some oil may remain in coastal areas for some time after a spill, as was observed along the Gulf Coast following the *Macondo* well blowout and spill.

B.2.3.1.1. Shallow Water

Due to the distance from shore, oil spilled as a result of a blowout in shallow water could reach shore within 1-3 weeks and could continue until the well is killed or capped and the oil dissipates offshore. Therefore, it is estimated that initial shoreline oiling would likely occur for 2-5 months following a catastrophic blowout. Some shoreline areas could be re-oiled during this timeframe dependent upon the weather conditions at the time of the spill as well as the persistence of the spilled oil.

B.2.3.1.2. Deep Water

Intervention is more difficult and would take longer in deeper water, in part, because at these water depths these intervention efforts are conducted by remotely operated vehicles. In general, most of the deep water in the Gulf of Mexico is located farther from shore and, therefore, it is assumed that oil would reach shore within 2-4 weeks. However, for the few deepwater areas that are located closer to shore, such as in the Mississippi Canyon Area, the amount of estimated time until shoreline contact could be the same as the shallow-water scenario above (1-3 weeks). The length of shoreline oiled would continue to increase and previously oiled areas could be re-oiled until the well is killed or capped (3-4 months) and the oil dissipates offshore (1-2 months). Therefore, initial shoreline oiling could occur from 3 months up to 6 months following a catastrophic blowout. Persistent shoreline oiling is discussed in **Chapter B.2.4** (Phase 4) below.

B.2.3.2. Volume of Oil Contacting Shore

In the event of a catastrophic spill, not all of the oil spilled would contact shore. The amount of oil recovered and chemically or naturally dispersed would vary. For example, the following are recovery and cleanup rates from previous high-volume, extended spills:

- 10-40 percent of oil recovered or cleaned up (including burned, chemically dispersed, and skimmed);
- 25-40 percent of oil naturally dispersed, evaporated, or dissolved; and
- 20-65 percent of the oil remains available for offshore or inshore contact.

In the case of the *Macondo* well blowout and spill, the "expected" scenario, developed by the Oil Budget Calculator Science and Engineering Team of The Federal Interagency Solutions Group, suggests that more than one quarter (29%) was naturally or chemically dispersed into Gulf waters, while burning, skimming, and direct recovery from the wellhead removed one quarter (25%) of the oil released. Less than one quarter (23%) of the total oil naturally evaporated or dissolved. The residual amount, just under one quarter (23%), remained in the Gulf of Mexico as a light sheen or as tarballs that have washed ashore or are buried in sand and other sediments (The Federal Interagency Solutions Group, 2010).

For planning purposes, USCG estimates that 5-30 percent of oil will reach shore in the event of an offshore spill (33 CFR part 154, Appendix C, Table 2). Using the USCG assumptions, a catastrophic spill could result in a large amount of oil reaching shore.

B.2.3.3. Length of Shoreline Contacted

While larger spill volumes increase the chance of oil reaching the coast, other factors that influence the length and location of shoreline contacted include the duration of the spill and the well's location in relation to winds, currents, and the shoreline. Depending upon winds and currents throughout the spill event, already impacted areas could be re-oiled. As seen with the *Deepwater Horizon* oil spill, as the spill continued, the length of oiled shoreline at any one time increased by orders of magnitude as follows:

Duration of Spill	Length of Shoreline Oiled[1]
30 days	0-50 miles
60 days	50-100 miles
90 days	100-1,000 miles
120 days	>1,000 miles[2]

[1] Not cumulative.
[2] Length was extrapolated.

Source: Operational Science Advisory Team, 2011.

B.2.3.3.1. Shallow Water

While a catastrophic spill from a shallow-water blowout is expected to be lower in volume than a deepwater blowout, as explained in **Chapter B.2.2.3**, the site would typically be closer to shore, allowing less time for oil to be weathered, dispersed, and recovered. This could result in a more concentrated and toxic oiling of the shoreline.

B.2.3.3.2. Deep Water

While a catastrophic spill from a deepwater blowout is expected to have a much greater volume than a shallow-water blowout (refer to **Chapter B.2.2.3**), the site would typically be farther from shore, allowing more time for oil to be weathered, dispersed, and recovered. This could result in broader, patchier oiling of the shoreline.

Translocation of the spilled oil via winds and currents is also a factor in the length of shoreline contacted. For example, oil could enter the Loop Current and then the Gulf Stream. However, the longer it takes oil to travel, the more it would degrade, disperse, lose toxicity, and break into streamers and tarballs (USDOC, NOAA, Office of Response and Restoration, 2010d).

B.2.3.4. Severe Weather

The official Atlantic hurricane season runs from June 1st through November 30th, with a peak in hurricane probability in September. In an average Atlantic season, there are 11 named storms, 6 hurricanes, and 2 Category 3 or higher storms (USDOC, NOAA, National Weather Service, 2010). In the event of a hurricane, vessels would evacuate the area, delaying response efforts, including the drilling of relief wells. The storm surge may push oil to the coastline and inland as far as the surge reaches, or the storm surge may remove the majority of oil from shore, as seen in some of the previous spills reviewed.

Movement of oil during a hurricane would depend greatly on the track of the hurricane in relation to the slick. A hurricane's winds rotate counter-clockwise. In general, a hurricane passing to the west of the slick could drive oil to the coast, while a hurricane passing to the east of the slick could drive the oil away from the coast.

Severe weather may distribute spilled oil over a wide area. Storm surge may carry oil into the coastal and inland waters and shore. Debris resulting from severe weather may be contaminated by oil. Thus, the responders need to take proper precautions if weathered oil is present. Weather that results in waves greater than 3 ft (1 m) prevents skimming in coastal waters so there is greater likelihood of contact with the shoreline. Severe weather would also displace or destroy shoreline boom so that oil could come into contact with the shoreline until responders put the boom back in place. Severe weather could require that assets be relocated inland. The response would be delayed because following the severe weather event the assets would need to be transported back to the staging areas. The speed with which the assets could be brought back to the locations would depend upon on the condition of the roads and bridges for traffic resumption and the amount of debris potentially blocking the roads.

The USEPA, USCG, other Federal response agencies, and applicable State agencies would work together to address oil spills reported to the National Response Center or reported by emergency responders before, during, or after a hurricane occurs. Response personnel will cleanup significant spills and take other actions appropriate to protect public health and the environment. This response would cover any OCS spills that may occur as a result of the hurricane or preexisting at the time of the hurricane. Response activities may be interrupted or complicated during a hurricane event. Oil from an ongoing OCS spill event may be washed ashore during a hurricane event; could be weathered, diluted, or washed farther inland; and could be mixed with other contaminants from other sources released during a hurricane event (e.g., heating oil or industrial chemicals). For example, onshore sources account for most of the oil spilled during the past few hurricane seasons that has resulted in oiled property. After Hurricane Sandy, some oil heating tanks flooded and caused oiling of a property owner's own building(s). As such, depending on circumstances, a hurricane event during an OCS spill event could complicate and exacerbate spill impacts and response operations, but could also increase weathering and dilution.

B.2.3.5. Onshore Cleanup Activities

A large-scale response effort would be expected for a catastrophic blowout. The number of vessels and responders would increase steadily as the spill continued. In addition to the response described in **Chapter B.2.2.7**, the following response is also estimated to occur once the spill contacts the shore.

B.2.3.5.1. Shallow Water

- There would be 5-10 staging areas established.
- Weathering permitting, about 200-300 skimmers could be deployed near shore to protect coastlines.

B.2.3.5.2. Deep Water

- There would be 10-20 staging areas established.
- Weather permitting, about 500-600 skimmers could be deployed near shore to protect coastlines. As seen in Louisiana following the *Macondo* well blowout and spill, a few hundred coastal skimmers could still be in operation a few months after the well is capped or killed (The State of Louisiana, 2010).

B.2.3.5.3. Response Considerations for Sand Beaches for Both Shallow-Water and Deepwater Spills

- No mechanical techniques allowed in some areas.
- Surface residence balls (SRB's), also commonly known as tarballs, and surface residence patties (SRP's) are subject to smearing during the day; therefore, much of the beach cleanup can be expected to be conducted at night, if the weather is warm.
- There are marked differences in the sediments on the central Louisiana coast as compared with the Gulf beaches of Alabama, Florida, and Mississippi; therefore, no single technique will be universally applicable for cleaning sand beaches.

- Typically, sand sieving, shaking, and sifting beach cleaning machines will be utilized. The depth of cut below the sand surface can be expected to typically range from 0 to 12 inches (in) (0 to 30 centimeters [cm]) when using this equipment.
- It is anticipated that the responders will be instructed that no disturbance will be allowed below 18 in (46 cm). However, oil can be expected down to a depth of 24-26 in (61-66 cm) below the sand surface.
- Repetitive tilling and mixing may be used at beaches such as Grand Isle, using agriculture plows and discs in combination with beach cleaning machines. Sand washing treatment also may take place at beaches such as Grand Isle's beach. Sand washing includes a sand sieve/shaker to remove debris and large oil particles and a heated washing system. Average daily throughput for these systems would be 290 cubic yards per day. Sand treated in this manner is typically treated by sediment relocation, which is where the sand is moved to an active intertidal zone

B.2.3.5.4. Response Considerations for Marshes for Both Shallow-Water and Deepwater Spills

- Lightly oiled marsh may be allowed to recover naturally; the oil may be allowed to degrade in place or to be removed by tidal or wave action.
- Moderately or heavily oiled marsh could be cleaned by vacuuming or skimming from boats in conjunction with flushing to enhance oil recovery rates, low pressure flushing (with water comparable to marsh type), manual removal by hand or mechanized equipment, or vegetation cutting.
- In some heavily oiled areas, in-situ burning may be an option if water covers the sediment surface. This technique is only considered when the source is contained due to potential re-oiling of the area. Surface washing agents are also a technique that might be utilized.
- Bioremediation may be utilized but mostly as a secondary treatment after bulk removal.

B.2.3.5.5. Response Considerations for Nearshore Waters for Both Shallow-Water and Deepwater Spills

- Nearshore submerged oil is difficult to recover and hard to locate; vacuums and snares could be used.
- In the vicinity of marsh areas, skimming techniques with flushing could be utilized where warranted. In areas too shallow to use skimmers, oil removal could be accomplished using vacuum systems, in conjunction with flushing as needed. Booming could also be used to temporarily contain mobile slicks until they are recovered.

B.2.4. Phase 4—Post-Spill, Long-Term Recovery

During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and that cleanup activities are concluding. While it is assumed that the majority of spilled oil floating on surface waters would be dissipated within 30-60 days of stopping the flow, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill (USDOI, FWS, 2004). On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms (USDOI, FWS, 2010a). As of this writing, residual oil can still be found in Louisiana marshes and oil still sporadically appears as tarballs and tar patties on Alabama and Florida beaches following the *Deepwater Horizon* explosion, oil spill, and response in 2010. In addition, oil may still reside in deeper waters in sediments within close proximity of the wellhead, where response cleanup activities may not be pursued (OSAT, 2010).

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) jurisdictional considerations. To determine which cleanup method is most appropriate during a spill response, decisionmakers must assess the severity and nature of the injury using Shoreline Cleanup and Assessment Team survey observations. These onsite decisionmakers must also estimate the time it will take for an area to recover in the absence of cleanup (typically considering short term to be 1-3 years, medium term to be 3-5 years, and long term greater than 5 years) (National Response Team, 2010).

B.2.4.1. Response Considerations for Sand Beaches, Marshes, and Nearshore Waters for both Shallow-Water and Deepwater Spills

Once oiled, it can be expected that the shoreline response techniques employed in the initial phase of a response will become more extensive and continue for some time (**Chapters B.2.3.5.3, B.2.3.5.4, and B.2.3.5.5**). Spill response post-*Macondo* well blowout and spill is still ongoing in some of the more heavily oiled areas in Louisiana and in other areas, such as Florida and Alabama, that experience periodic re-oiling from submerged oil mats that lie in the inshore surf zone in troughs between the sand bars or from buried oil onshore that resurfaces. The three types of oil residue that have been identified as challenging or potentially damaging to the environment if removed includes the following: (1) supra-tidal buried oil (buried below the 6-in [15-cm] surface cleaning depth restriction near sensitive habitats); (2) small surface residual balls, which are oil residue left behind after beaches are cleaned; and (3) surf zone submerged oil mats. Additional information regarding shoreline response considerations can be found in **Chapter 3.2.1.9** of this Supplemental EIS.

B.3. DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

B.3.1. Long Duration—Large Volume Spill within the Gulf of Mexico

The following resource descriptions and impact analyses examined only the applicable portions of the scenario (described fully in **Chapter 3** and summarized in **Table B-4**).

B.3.1.1. Air Quality

Phase 1—Initial Event

A catastrophic blowout close to the water surface would initially emit large amounts of methane and other gases into the atmosphere. If high concentrations of sulfur are present in the produced gas, hydrogen sulfide (H_2S) could present a hazard to personnel. The natural gas H_2S concentrations in the Gulf of Mexico OCS are generally low; however, there are areas such as the Norphlet formation in the northeastern Gulf of Mexico, for example, that contain levels of H_2S up to 9 percent. Ignition of the blowout gas and subsequent fire would result in emissions of nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), volatile organic compounds (VOC's), particulate matter (PM_{10}), and fine particulate matter ($PM_{2.5}$). The fire could also produce polycyclic aromatic hydrocarbons (PAH's), which are known to be hazardous to human health. The pollutant concentrations would decrease with downwind distance. A large plume of black smoke would be visible at the source and may extend a considerable distance downwind. However, with increasing distance from the fire, the gaseous pollutants would undergo chemical reactions, resulting in the formation of fine particulate matter ($PM_{2.5}$) that includes nitrates, sulfates, and organic matter. The $PM_{2.5}$ concentrations in the plume would have the potential to temporarily degrade visibility in any affected Prevention of Significant Deterioration (PSD) Class I areas (i.e., National Wilderness Areas and National Parks) and other areas where visibility is of significant value. Organic aerosols formed downwind from the *Macondo* well blowout and spill (de Gouw et al., 2011), during which the lightest compounds, the VOC's, in the oil from the *Macondo* well blowout and spill evaporated within hours and during which the heavier compounds took longer to evaporate, contributing to the formation of air pollution particles downwind.

Phase 2—Offshore Spill

In the Gulf of Mexico, evaporation from the oil spill would result in concentrations of VOC's in the atmosphere, including chemicals that are classified as being hazardous. The VOC concentrations would occur anywhere where there is an oil slick, but they would be highest at the source of the spill because the rate of evaporation depends on the volume of oil present at the surface. The VOC concentrations would decrease with distance as the layer of oil gets thinner. The lighter compounds of VOC's would be most abundant in the immediate vicinity of the spill site. The heavier compounds would be emitted over a longer period of time and over a larger area. Some of the compounds emitted could be hazardous to workers in close vicinity of the spill site. The hazard to workers can be reduced by monitoring and using protective gear, including respirators, as well as limiting exposure through limited work shifts, rotating workers in close vicinity of the spill site. The hazard to workers can be reduced by monitoring and using protective gear, including respirators, as well as limiting exposure through limited work shifts, rotating workers out of high exposure areas, and pointing vessels into the wind. During the *Macondo* well blowout and spill, air samples collected by individual offshore workers of British Petroleum (BP), the Occupational Safety and Health Administration (OSHA), and USCG showed levels of benzene, toluene, ethylbenzene, and xylene that were mostly under detection levels. All samples had concentrations below the OSHA permissible exposure limits and the more stringent ACGIH (American Conference of Governmental Industrial Hygienists) threshold limit values (U.S. Dept. of Labor, OSHA, 2010a).

The VOC emissions that result from the evaporation of oil contribute to the formation of particulate matter ($PM_{2.5}$) in the atmosphere. In addition, VOC's could cause an increase in ozone levels, especially if the release were to occur on a hot, sunny day with sufficient concentrations of NO_x present in the lower atmosphere. However, because of the distance of the proposed CPA lease sale area from shore, the oil slick would not likely have any effects on onshore ozone concentrations; however, if there were any effects to onshore ozone concentrations, they would be likely only be temporary in nature and last at most the length of time of the spill duration.

It is assumed that response efforts would include hundreds of in-situ or controlled burns, which would remove an estimated 5-10 percent of the volume of oil spilled. This could be as much as 720,000 bbl of oil for a spill of 60,000 bbl per day for 90 days. In-situ burning would result in ambient concentrations of CO, NO_x, SO_2, PM_{10}, and $PM_{2.5}$ very near the site of the burn and would generate a plume of black smoke. The levels of $PM_{2.5}$ could be a hazard to personnel working in the area, but this could be effectively mitigated through monitoring and relocating vessels to avoid areas of highest concentrations. In an experiment of an in-situ burn off Newfoundland, it was found that CO, SO_2, and NO_2 were measured only at background levels and were frequently below detection levels (Fingas et al., 1995). Limited amounts of formaldehyde and acetaldehyde were measured, but concentrations were close to background levels. Measured values of dioxins and dibenzofurans were at background levels. Measurements of PAH in the crude oil, the residues, and the air indicated that the PAH in the crude oil are largely destroyed during combustion (Fingas et al., 1995).

While containment operations may be successful in capturing some of the escaping oil and gas, recovery vessels may not be capable of storing the crude oil or may not have sufficient storage capacity. In this case, excess oil would be burned; captured gas cannot be stored or piped to shore so it would be flared. For example, in the *Macondo* well blowout and spill, gas was flared at the rate of 100-200 million cubic feet per day and oil burned at the rate of 10,000-15,000 bbl per day. The estimated NO_x emissions are about 13 tons per day. The SO_2 emissions would be dependent on the sulfur content of the crude oil. For crude oil with a sulfur content of 0.5 percent, the estimated SO_2 emissions are about 16 tons per day. Particulate matter in the plume would also affect visibility. Flaring or burning activities upwind of a PSD Class I area, e.g., the Breton National Wilderness Area, could adversely affect air quality there because of increased levels of SO_2, PM_{10}, and $PM_{2.5}$, and because of reduced visibility.

Phase 3—Onshore Contact

As the spill nears shore, there would be low-level concentrations of odor-causing pollutants associated with evaporative emissions from the oil spill. These may cause temporary eye, nose, or throat irritation, nausea, or headaches, but the doses are not thought to be high enough to cause long-term harm (USEPA, 2010b). However, responders could be exposed to levels higher than OSHA occupational permissible exposure levels (U.S. Dept. of Labor, OSHA, 2010b). During the *Deepwater Horizon* explosion, oil spill, and response, USEPA took air samples at various onshore locations along the length of the Gulf coastline. All except three measurements of benzene were below 3 parts per billion (ppb). The highest level was 91 ppb. Emissions of benzene to the atmosphere result from gasoline vapors, auto exhaust, and chemical production and user facilities. Ambient concentrations of benzene up to and greater than 5 ppb have been measured in industrial areas such as Houston, Texas; in various urban areas during rush hour; and inside the homes of smokers (U.S. Dept. of Human and Health Services, 2007). The following daily median benzene air concentrations were reported in the Volatile Organic Compound National Ambient Database (1975-1985): remote (0.16 ppb); rural (0.47 ppb); suburban (1.8 ppb); urban (1.8 ppb); indoor air (1.8 ppb); and workplace air (2.1 ppb). The outdoor air data represent 300 cities in 42 states, while the indoor air data represent 30 cities in 16 states (Shah and Singh, 1988).

During the *Deepwater Horizon* explosion, oil spill, and response, air samples collected by BP, OSHA, and USCG near shore showed levels of benzene, toluene, ethylbenzene, and xylene that were mostly under detection levels. Among the 28,000 personal benzene samples taken by BP, there was only 1 sample where benzene exceeded the OSHA occupational permissible exposure limits, and 6 additional validated constituents were in excess of the ACGIH threshold limit value. All other sample concentrations were below the more stringent ACGIH threshold limit values (U.S. Dept. of Labor, OSHA, 2010a). All measured concentrations of toluene, ethylbenzene, and xylene were well within the OSHA occupational permissible exposure levels and ACGIH threshold limit values.

Phase 4—Post-Spill, Long-Term Recovery and Response

There would be some residual air quality impacts after the well is capped or killed. As most of the oil would have been burned, evaporated, or weathered over time, air quality would return to pre-oil spill conditions. While impacts to air quality are expected to be localized and temporary, adverse effects that may occur from the exposure of humans and wildlife to air pollutants could have long-term consequences.

Overall Summary and Conclusion (Phases 1-4)

The OCS oil- and gas-related catastrophic event could include the release of oil, condensate, or natural gas or chemicals used offshore or pollutants from the burning of these products. The air pollutants include criteria National Ambient Air Quality Standards (NAAQS) pollutants, volatile and semi-volatile organic compounds, H_2S, and methane. If a fire was associated with the event, it would produce a broad array of pollutants, including all NAAQS-regulated primary pollutants, including NO_2, CO, SO_x, VOC, PM_{10}, and $PM_{2.5}$. Response activities that could impact air quality include in-situ burning, the use of flares to burn gas and oil, and the use of dispersants applied from aircraft. Measurements taken during an in-situ burning show that a major portion of compounds was consumed in the burn; therefore, pollutant concentrations would be expected to be within the NAAQS. In a recent analysis of air in coastal communities, low levels of dispersant components, which are also used in everyday household products, were identified. These response activities are temporary in nature and occur offshore; therefore, there are little expected impacts from these actions to onshore air quality. Catastrophic events involving high concentrations of H_2S could result in deaths as well as environmental damage. Regulations and NTL's mandate safeguards and protective measures, which are in place, to protect workers from H_2S releases. Other emissions of pollutants into the atmosphere from catastrophic events 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.

Overall, since loss of well-control events, blowouts, and fires are rare events and of short duration, potential impacts to air quality are not expected to be significant except in the rare case of a catastrophic event. To date, air monitoring conducted following the *Macondo* well blowout and spill, has not found any pollutants at levels expected to cause long-term harm (USEPA, 2010a).

B.3.1.2. Water Quality

Phase 1—Initial Event

Offshore Water Quality

During the initial phase of a catastrophic blowout, water quality impacts include the disturbance of sediments and the release and suspension of oil and natural gas (primarily methane) into the water column. These potential impacts are discussed below. As this chapter deals with the immediate effects of a blowout that would be located at least 3 nmi (3.5 mi; 5.6 km) from shore, it is assumed that there would be no impacts on coastal water quality during this initial stage.

Disturbance of Sediments

A catastrophic blowout below the seafloor, outside the wellbore (**Table B-1**) has the potential to resuspend sediments and disperse potentially large quantities of bottom sediments. Some sediment could travel several kilometers, depending on particle size and subsea current patterns. In the deep Gulf of Mexico, surficial sediments are mostly composed of silt and clay, and, if resuspended, could stay in the water column for several hours to days. Bottom current measurements in the deep Gulf of Mexico were synthesized as part of the MMS Deepwater Reanalysis study and have been measured to reach 90 centimeters/second (cm/sec) (35.4 inches/second [in/sec]) with mean flows of 0.4-21 cm/sec (0.2-8.3 in/sec) (Nowlin et al., 2001). At these mean flow rates, resuspended sediment could be transported 0.3-18 km per day (0.2-11 mi per day).

Sediment resuspension can lead to a temporary change in the oxidation-reduction chemistry in the water column, including a localized and temporal release of any formally sorbed metals, as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982). Sediments also have the potential to become contaminated with oil components.

A subsea release also has the potential to destabilize the sediments and create slumping or larger scale sediment movements along depth gradients. These types of events would have the potential to move and/or damage any infrastructure in the affected area.

Release and Suspension of Oil into the Water Column

A subsea release of hydrocarbons at a high flow rate has the potential to disperse and suspend plumes of oil droplets (chemically dispersed or otherwise) within the water column and to induce large patches of sheen and oil on the surface. These dispersed hydrocarbons may adsorb onto marine detritus (marine snow), suspended sediments, or may be mixed with drilling mud and deposited near the source. Mitigation efforts such as burning may introduce hydrocarbon byproducts into the marine environment, which would be distributed by surface currents. The acute and chronic sublethal effects of these dilute suspended “plumes” are not well understood and require future research efforts.

As a result of the *Macondo* well blowout and spill, a subsurface oil and gas plume was discovered in deep waters between ~1,100 and 1,300 m (3,609 and 4,265 ft) (e.g., Diercks et al., 2010) in addition to the surface slick. Measurable amounts of hydrocarbons (dispersed or otherwise) were detected in the subsurface plumes and on the seafloor in the vicinity of the release (e.g., Diercks et al., 2010; OSAT, 2010). In the *Macondo* well blowout and spill subsurface plume, half-lives were estimated for petroleum hydrocarbons and n-alkanes on the order of 1 month and several days, respectively, indicating the impacts of various weathering processes (Reddy et al., 2011 and references therein). After the *Ixtoc I* well blowout and spill in 1979, which was located 50 mi (80 km) offshore in the Bay of Campeche, Mexico, some subsurface oil was also observed dispersed within the water column (Boehm and Fiest, 1982); however, the scientific investigations were limited (Reible, 2010). The water quality of offshore waters would be affected by the dissolved components and oil droplets that are small enough that they do not rise to the surface or are mixed down by surface turbulence. In the case of subsurface oil plumes, it is important to remember that these plumes would be affected by subsurface currents, dilution, and natural physical, chemical, and biological degradation processes including weathering.

Large quantities of oil put into offshore water may alter the chemistry of the sea with unforeseeable results. The properties and persistence of oil, including oil in the Gulf of Mexico, is further discussed in **Chapter B.2.2.4**. The VOC’s, including benzene, toluene, ethylbenzene, and xylenes (also referred to as

BTEX), are highly soluble and can have acutely toxic effects; however, VOC's are light-weight oil components and tend to evaporate rather than persist in the environment (Michel, 1992). Middle-weight organic components tend to pose the greatest risk in the environment because they are more persistent in the environment, are more bioavailable, and include polycyclic aromatic hydrocarbons (PAH's), which have high toxicities (Michel, 1992). To determine the overall toxicity of PAH's in water or sediment, the contributions of every individual PAH compound in the petroleum mixture must be included (USEPA, 2011). This approach was used during the *Macondo* well blowout, spill and response in determining the potential risk of PAH's in both water and sediment to humans or animals in the environment (OSAT, 2010). Heavier components of crude oil tend to pose less risk of toxicity because they are not very soluble in water and therefore are less bioavailable.

The oil that entered the Gulf of Mexico from the *Macondo* well blowout and spill was a South Louisiana sweet crude oil (i.e., low in sulfur) (USDOC, NOAA, 2010b). This oil is less toxic than other crude oils in general because this oil is lower in PAH's than many other crude oils. Studies indicate that the oil contained approximately 3.9 percent PAH's by weight, which results in an estimated release of 2.1×10^{10} grams of PAH's (Reddy et al., 2011; Reddy, official communication, 2012). The oil was also fairly high in alkanes (organic compounds containing only carbon and hydrogen and single bonds, sometimes called paraffin or aliphatic compounds) (USDOC, NOAA, 2010b). Because alkanes are simple hydrocarbons, these oils are likely to undergo biodegradation more easily (USDOC, NOAA, 2010b).

Release of Natural Gas (Methane) into the Water Column

A catastrophic blowout could release natural gas into the water column; the amount of gas released is dependent upon the water depth, the natural gas content of the formation being drilled, and its pressure. Methane is the primary component of natural gas. Methane may stay in the marine environment for long periods of time (Patin, 1999; page 237), as methane is highly soluble in seawater at the high pressures and cold temperatures found in deepwater environments (NRC, 2003; page 108). However, methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974; page 23). In addition to methane, natural gas contains smaller percentages of other gases such as ethane, propane, and to a much lesser degree H_2S (NaturalGas.org, 2012), which can be toxic in the environment. The majority of natural gas components including methane are carbon sources, and their introduction into the marine environment could result in reducing the dissolved oxygen levels because of microbial degradation potentially creating hypoxic or "dead" zones. Unfortunately, little is known about methane toxicity in the marine environment, but there is concern as to how methane in the water column might affect fish. Further discussion of natural gas released during the *Macondo* well blowout and spill is given in **Chapter B.2.2.5**.

Phase 2—Offshore Spill

Offshore Water Quality

The water offshore of the Gulf's coasts can be divided into two regions: the continental shelf and slope (<1,000 ft; 305 m) and deep water (>1,000 ft; 305 m). Waters on the continental shelf and slope are heavily influenced by the Mississippi and Atchafalaya Rivers, the primary sources of freshwater, sediment, nutrients, and pollutants from a huge drainage basin encompassing 55 percent of the continental U.S. (Murray, 1998). Lower salinities are characteristic nearshore where freshwater from the rivers mix with Gulf waters. The presence or extent of a nepheloid layer, a body of suspended sediment at the sea bottom (Kennett, 1982, page 524), affects water quality on the shelf and slope. Deep waters east of the Mississippi River are affected by the Loop Current and associated warm-core (anti-cyclonic) eddies, which flush the area with clear, low-nutrient water (Muller-Karger et al., 2001) (**Figure B-2**). However, cold-core cyclonic eddies (counter-clockwise rotating) also form at the edge of the Loop Current and are associated with upwelling and nutrient-rich, high-productivity waters, although the extent of this flushing can vary seasonally.

While response efforts would decrease the fraction of oil remaining in Gulf waters, significant amounts of oil would remain. Natural processes will physically, chemically, and biologically aid the degradation of oil (NRC, 2003). The physical processes involved include evaporation, emulsification, and dissolution, while the primary chemical and biological degradation processes include photo-oxidation and biodegradation (i.e., microbial oxidation). Water quality would not only be impacted by the oil, gas, and their respective components, but also to some degree, from cleanup and mitigation efforts, such as from increased vessel traffic and the addition of dispersants and methanol to the marine environment.

In the case of a catastrophic subsea blowout in deep water, it is assumed that large quantities of subsea dispersants would be used. The positive effect of using dispersants is that the oil, once dispersed, may be more available to be degraded (however, we note that contrary findings for beached oil were presented by Hamdan and Fulmer, 2011). The negative effect is that the oil, once dispersed, is also more bioavailable to have toxic effects to microorganisms as well. The toxicity of dispersed oil in the environment would depend on many factors, including the effectiveness of the dispersion, temperature, salinity, degree of weathering, type of dispersant, and degree of light penetration in the water column (NRC, 2005). The toxicity of dispersed oil is primarily because of the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

As a result of the use of dispersants, it would be more likely for clouds or plumes of dispersed oil to occur near the blowout site as was seen during the *Macondo* well blowout and spill. Dissolved oxygen levels are a concern with any release of a carbon source, such as oil and natural gas, and became a particular concern during the *Macondo* well blowout and spill since dispersants were used in deep waters for the first time. In areas where plumes of dispersed oil were previously found, dissolved oxygen levels decreased by about 20 percent from long-term average values in the GOM of ~6.9 milligrams/liter (spring climatological mean at 1,500-m [4,921 -ft] depth); however, scientists reported that these levels stabilized and were not low enough to be considered hypoxic (Joint Analysis Group, 2010b; USDOC, NOAA, 2010d). The drop in oxygen, which did not continue over time, has been attributed to microbial degradation of the oil.

Phase 3—Onshore Contact

Coastal Water Quality

Water quality governs the suitability of waters for plant, animal, and human use. Water quality is important in the bays, estuaries, and nearshore coastal waters of the Gulf because these waters provide feeding, breeding, and/or nursery habitat for many invertebrates and fishes, as well as sea turtles, birds, and marine mammals. A catastrophic spill would significantly impact coastal water quality in the Gulf of Mexico. Water quality prior to the *Macondo* well blowout and spill was rated as fair while sediment quality was rated as poor (USEPA, 2008). In addition, the coastal habitat index, a rating of wetlands habitat loss, was also rated as poor. Both the sediment quality and the coastal habitat index affect water quality.

Though response efforts would decrease the amount of oil remaining in Gulf waters and reduce the amount of oil contacting the coastline, significant amounts of oil would remain. Coastal water quality would be impacted not only by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. Increased vessel traffic, hydromodification, and the addition of dispersants and methanol in an effort to contain, mitigate, or clean up the oil may also tax the environment.

The use of dispersants as a response tool involves a tradeoff. The purpose of chemical dispersants is to facilitate the movement of oil into the water column in order to encourage weathering and biological breakdown of the oil (i.e., biodegradation) (NRC, 2005; Australian Maritime Safety Authority, 2010). Thus, the tradeoff is generally considered to be oiling of the shoreline and surface of the water versus the water column and benthic resources (NRC, 2005). If the oil moves into the water column and is not on the surface of the water, it is less likely to reach sensitive shore areas (USEPA, 2010b). Since sea birds are often on the surface of the water or in shore areas, dispersants are also considered to be very effective in reducing the exposure of sea birds to oil (Australian Maritime Safety Authority, 2010). In addition to dispersion being enhanced by artificial processes, oil may also be dispersed from natural processes including both (bio)chemical and physical processes. For instance, microbial metabolism of crude oil results in the dispersion of oil (Bartha and Atlas, 1983), and conditions at the source of the oil/gas leak (e.g., orifice size and shape) may cause physical dispersion of the oil. Dispersion has both positive and negative effects. The positive effect is that the oil, once dispersed, is more available to be degraded. The negative effect is that the oil, once dispersed, is also more bioavailable to have toxic effects to microorganisms as well. For example, a recent study using mesocosm experiments suggested that dispersed oil could disrupt coastal microbial foodwebs in the northern Gulf of Mexico, reducing the flow of carbon to higher trophic levels (Ortmann et al., 2012). The toxicity of dispersed oil in the environment will depend on many factors, including the effectiveness of the dispersion, temperature, salinity, the degree of weathering, type of dispersant, and the degree of light penetration in the water column (NRC, 2005). The toxicity of dispersed oil is primarily because of the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

Oxygen and nutrient concentrations in coastal waters vary seasonally. The zone of hypoxia (depleted oxygen) on the Louisiana-Texas shelf occurs seasonally and is affected by the timing of freshwater discharges from the Mississippi and Atchafalaya Rivers. The hypoxic conditions continue until local wind-driven circulation mixes the water again. The 2010 hypoxic zone could not be linked to the *Macondo* well blowout and spill in either a positive or a negative manner (Louisiana Universities Marine Consortium, 2010). Nutrients from the Mississippi River nourished phytoplankton and contributed to the formation of the hypoxic zone.

Phase 4—Post-Spill, Long-Term Recovery and Response

The leading source of contaminants that impairs coastal water quality in the Gulf of Mexico is urban runoff. It can include suspended solids, heavy metals, pesticides, oil, grease, and nutrients (such as from lawn fertilizer). Urban runoff increases with population growth, and the Gulf Coast region has experienced a 109 percent population growth since 1970, with an additional expected 15 percent increase expected by 2020 (USDOC, NOAA, 2011). Other pollutant source categories include (1) agricultural runoff, (2) municipal point sources, (3) industrial sources, (4) hydromodification (e.g., dredging), and (5) vessel sources (e.g., shipping, fishing, and recreational boating). The NRC (2003, Table I-4, page 237) estimated that, on average, approximately 26,324 bbl of oil per year entered Gulf waters from petrochemical and oil refinery industries in Louisiana and Texas. The Mississippi River introduced approximately 3,680,938 bbl per year (NRC, 2003, Table I-9, page 242) into the waters of the Gulf. Hydrocarbons also enter the Gulf of Mexico through natural seeps in the Gulf at a rate of approximately 980,392 bbl per year (a range of approximately 560,224-1,400,560 bbl per year) (NRC, 2003, page 191). Produced water (formation water) is, by volume, the largest waste stream from the oil and gas industry that enters Gulf waters (e.g., **Table B-3**). The NRC has estimated the quantity of oil in produced water entering the Gulf per year to be 473,000 bbl (NRC, 2003, page 200, Table D-8).[1] These sources total about 5.5 MMbbl of oil per year that routinely enters Gulf of Mexico waters. In comparison, a catastrophic spill of 30,000-60,000 bbl per day for 90-120 days would spill a total of 2.7-7.2 MMbbl of oil. When added to the other sources of oil listed above, this would result in a 48- to 129-percent increase in the volume of oil entering the water during the year of the spill. In addition, the oil from a catastrophic spill will be much more concentrated in some locations than the large number of other activities that release oil into the Gulf of Mexico. **Chapter B.2.2.4** discusses the properties and persistence of oil in the environment.

Overall Summary and Conclusion (Phases 1-4)

During Phase 1 of the catastrophic blowout scenario, impacts are not expected to coastal water quality. Instead, the initial impacts will include degradation of offshore water quality, disturbance and degradation of sediments, and the release and suspension of oil and natural gas into the water column, including the possible formation of plumes. Fine sediments could be transported away from the spill site.

As the spill continues during Phase 2, response efforts and natural degradation processes would decrease the amount of oil in the Gulf, but significant amounts of oil would remain to impact water and sediment quality. Water and sediment quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. The use of dispersants as a response tool may make the oil more available to degradation, but it can also make the oil more bioavailable to have toxic effects on microorganisms as well. Furthermore, dispersed oil is more likely to form a plume.

[1] These numbers were generated from converting the units reported in the noted reference and do not imply any level of significance.

Onshore contact is made during Phase 3, so coastal sediment and water quality will be significantly impacted during this phase despite response efforts. Response efforts may even tax the coast to some degree. Natural and chemical dispersion may reduce the contact of oil with the shoreline but result in more oil in the water column and greater bioavailability of the dispersed oil.

The long-term recovery (Phase 4) of the water and sediment quality of the Gulf will depend on the properties and persistence of the oil as noted in **Chapter B.2.2.4**. Though the spill will increase the amount of oil entering the Gulf of Mexico, oil regularly enters the Gulf through sources such as oil refineries, the Mississippi River, produced water, and natural seeps. However, oil from a spill will be more concentrated than the oil input from these other sources.

B.3.1.3. Coastal Barrier Beaches and Associated Dunes

Phase 1—Initial Event

There would likely be no adverse impacts to coastal barrier beaches and associated dunes as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 2—Offshore Spill

There would likely be no adverse impacts to coastal barrier beaches and associated dunes as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 3—Onshore Contact

Barrier islands make up more than two-thirds of the northern Gulf of Mexico shore. Each of the barrier islands is either high profile or low profile, depending on the elevations and morphology of the island (Morton et al., 2004). The distinguishing characteristics of the high- and low-profile barriers relate to the width of the islands along with the continuity of the frontal dunes. Low-profile barriers are narrow with discontinuous frontal dunes easily overtopped by storm surge, which makes the island susceptible to over wash and erosion. This over wash can create channels to bring sand onto the island or into lagoons formed on these islands. High-profile barrier islands are generally wider than the low-profile islands and have continuous, vegetated, frontal dunes with elevations high enough to prevent over wash from major storm surge and, therefore, are less susceptible to erosion. The sand stored in these high-profile dunes allows the island to withstand prolonged erosion and therefore prevents breaching, which could result in damaging the island core.

The effects from oil spills depend on the geographic location, volume, and rate of the spill; type of oil; oil-slick characteristics; oceanic conditions and season at the time of the spill; and response and cleanup efforts. The effects could include changes in plant species diversity that could result in changes in forage areas for species using microfauna as a food base (Teal and Howarth, 1984). Further detail on this catastrophic OSRA run is contained in **Appendix C**.

As a result of a catastrophic spill, many of the barrier islands and beaches would receive varying degrees of oiling. Oil disposal on sand and vegetated sand dunes was shown in experiments by Webb (1988) to have little deleterious effects on the existing vegetation or on the recolonization of the oiled sands by plants. However, other studies have documented toxic effects of oil on barrier beach vegetation (Ko and Day, 2004). The depth of oiling would be variable, based on the wave environment and sediment source at a particular beach head. Layering of oil and sand could occur if it was not cleaned before another tidal cycle. However, most areas of oiling are expected to be light, and sand removal during cleanup activities should be minimized. The severity of oiling dictates the appropriate cleanup method to be utilized (refer to **Table B-4**).

In areas designated as natural wilderness areas (e.g., Breton National Wildlife Refuge and Gulf Islands National Seashore), land managers may require little to no disruption of the natural system. In these environments, it is preferred to let the oil degrade naturally without aggressive and intrusive cleanup procedures. Manual rather than mechanized removal techniques would be used in these areas and only if heavy oiling has occurred. Thus, these areas may not be treated as thoroughly as other shorelines. Oil would remain in place longer, weathering gradually while continuing to contaminate habitat, though mechanical disturbance would be minimized.

Once oil has reached the beaches and barrier islands and becomes buried or sequestered, it becomes difficult to treat. During wave events when the islands and beaches erode, the oil can become remobilized and transported. Thus, the fate of oil is not as simple as either reaching land, becoming sequestered, or being treated; but, it must be considered in terms of a continuing process of sequestration, remobilization, and transport.

For spilled oil to move onto beaches or across dunes, strong southerly winds must persist for an extended time prior to or immediately after the spill to elevate water levels. Strong winds, however, could reduce the impact severity at a landfall site by accelerating the processes of oil-slick dispersal, spill spreading, and oil weathering.

Bik et al. (2012) found that, despite the disappearance of visible surface oil on heavily oiled Gulf beaches impacted by the *Macondo* well blowout and spill, microbial communities showed significant changes in community structure, with a decrease in diversity and a shift toward dominance by fungal taxa, particularly known hydrocarbon-degrading genera. Likewise, nematode communities showed decreased diversity and increased dominance by predatory and scavenger taxa alongside an increased abundance of juveniles.

Due to the distance of beaches from deepwater blowouts and the combination of weathering and dispersant treatment of the oil offshore, the toxicity and quantity of the oil reaching shore should be greatly reduced, thereby minimizing the chances of irreversible damage to the impacted areas. A blowout in shallower waters near shore may have equal or greater impacts because of a shorter period of weathering and dispersion prior to shoreline contact, even though a smaller volume of spilled oil would be expected.

Vessel traffic in close proximity to barrier islands has been shown to move considerably more bottom sediment than tidal currents, thus increasing coastal and barrier island erosion rates. If staging areas for cleanup of a catastrophic spill are in close proximity to these islands, recovery time of the barrier islands could be greatly extended because of the large number of response vessels.

Phase 4—Post-Spill, Long-Term Recovery and Response

Oil or its components that remain in the sand after cleanup may be (1) released periodically when storms and high tides resuspend or flush beach sediments, (2) decomposed by biological activity, or (3) volatilized and dispersed. While it is assumed that the majority of spilled oil would be dissipated offshore within 1-2 months (depending on season and temperature) of stopping the flow, oil has the potential to persist in the environment long after a spill event. For example on sandy beaches, oil can sink deep into the sediments. As stranded oil weathers, some oil may become buried through natural beach processes and appear as surface residual balls (SRB's; <10 cm [4 in]) or as surface residual patties (SRP's; 10 cm to 1 m [4 in to 3 ft]) **(Table B-4)**. Such balls continue to provide a source of contamination with accompanying toxic effects.

The cleanup impacts of a catastrophic spill could result in short-term (up to 2 years) adjustments in beach profiles and configurations as a result of sand removal and disturbance during cleanup operations. Some oil contact to lower areas of sand dunes is expected. This contact 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 (Ko and Day, 2004).

The protection once afforded to inland marshes by coastal barrier beaches has been greatly reduced because of decreased elevations and the continued effect of subsidence, sea-level rise, and saltwater intrusion. A catastrophic spill has the potential to contribute to this reduction through increased erosion as a result of plant dieback and cleanup efforts.

Overall Summary and Conclusion (Phases 1-4)

As a result of a catastrophic spill, many of the barrier islands and beaches would receive varying degrees of oiling. However, most areas of oiling are expected to be lightly oiled, and sand removal during cleanup activities should be minimal. 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.

B.3.1.4. Wetlands

Phase 1—Initial Event

There would likely be no adverse impacts to wetlands as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 2—Offshore Spill

There would likely be no adverse impacts to wetlands as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 3—Onshore Contact

Coastal wetland habitats in the Gulf of Mexico occur as bands around waterways; broad expanses of saline, brackish, and freshwater marshes; mud and sand flats; and forested wetlands of cypress-tupelo swamps and bottomland hardwoods. Offshore oil spills would have a low probability of contacting and damaging any wetlands along the Gulf Coast, except in the case of a catastrophic event. This is because of the distance of the spill to the coast, the likely weathered condition of oil (through evaporation, dilution, and biodegradation) should it reach the coast, and because wetlands are generally protected by barrier islands, peninsulas, sand spits, and offshore currents.

While a catastrophic spill from a shallow-water blowout is expected to be lower in volume than a deepwater blowout, a potential shallow-water site could be closer to shore, allowing less time for oil to be weathered, dispersed, and recovered before it impacted coastal resources. A spill from a catastrophic blowout could oil a few to several hundred acres of wetlands depending on the depth of inland penetration (Burdeau and Collins, 2010). This would vary from moderate to heavy oiling. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

The NOAA Environmental Sensitivity Index (ESI) ranks shorelines according to their sensitivity to oil, the natural persistence of oil, and the expected ease of cleanup after an oil spill. These factors cause oil to persist in coastal and estuarine areas (USDOI, MMS, 2010). According to the ESI, the most sensitive shoreline types (i.e., sheltered tidal flats, vegetated low banks, salt/brackish-water marshes, freshwater marshes/swamps, and scrub-shrub wetlands) tend to accumulate oil and are difficult to clean, thus causing oil to persist in these coastal and estuarine areas (USDOI, MMS, 2010).

In the case of catastrophic spills in the GOM, preemptive oil-response strategies would be initiated and include the deployment of oil booms, skimmer ships, and barge barriers to protect the beaches and adjacent wetlands. Boom deployment must also include plans for monitoring and maintaining the protective boom systems to assure that these systems are installed and functioning properly and that they are not damaging the wetlands they are trying to protect. In most cases, the beach face would take the most oil; however, in areas where the marsh is immediately adjacent to the beach face or embayments, or in the case of small to severe storms, marshes would be oiled. For example, in Alabama, Mississippi, and Florida, severe weather could push oil into the tidal pools and back beach areas that support tidal marsh vegetation.

The primary factors that affect vegetation responses to oil are toxicity of the oil and extent of plant coverage, amount of contact with and penetration of the soil, plant species affected, oiling frequency, season, and cleanup activities (Mendelssohn et al., 2012). Previous studies of other large spills have shown that, when oil has a short residence time in the marsh and it is not incorporated into the sediments, the marsh vegetation has a high probability of survival, even though aboveground die-off of marsh vegetation may occur (Lin et al., 2002). However, if re-oiling occurs after the new shoots from an initial oiling are produced, such that the new shoots are killed, then the marsh plants may not have enough stored energy to produce a second round of new shoots. Other studies noted the utilization of dispersants in the proper dosages results in a reduction in marsh damage from oiling (Lin and Mendelssohn, 2009). The works of several investigators (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1987;

Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989) evaluated the effects of potential spills to area wetlands. For wetlands along the central Louisiana coast, the critical oil concentration is assumed to be 0.025 gallons per ft^2 (1.0 liter per m^2) of marsh. Concentrations less than this may cause diebacks for one growing season or less, depending upon the concentration and the season during which contact occurs. The duration and magnitude of a spill resulting from a catastrophic blowout could result in concentrations above this critical level and would result in longer term effects to wetland vegetation, including some plant mortality and loss of land.

Due to the distance of deep water from shore, the possibility of a spill from a deepwater blowout reaching coastal wetlands with the toxicity to significantly impact the coastal wetlands is low because of the response procedures implemented during a catastrophic spill. (It is assumed that oil would reach shore within 2-4 weeks.) Therefore, a spill from a shallow-water blowout is more likely to contribute to wetland damage. However, for the few deepwater areas that are located closer to shore, such as in the Mississippi Canyon Area, the amount of time before shoreline contact could occur could be estimated to be the same as the estimate given for the shallow-water scenario, i.e., 1-3 weeks.

Offshore skimming, burning, and dispersal treatments for the oil near the spill site would result in capture, detoxification, and dilution of the majority of oil spilled. The utilization of nearshore booming protection for beaches and wetlands could also help to reduce oiling of these resources, if done correctly. Booms deployed adjacent to marsh shorelines can be lifted by wave action onto marsh vegetation, resulting in plant mortality under the displaced booms. The activity of oil cleanup can result in additional impacts on wetlands if not done properly. During the *Deepwater Horizon* explosion, oil spill, and response, aggressive onshore and marsh cleanup methods (such as the removal by mechanized equipment, in-situ burning, etc.) were not extensively utilized. The severity of oiling is the main factor that dictates the appropriate marsh cleanup method to be utilized (refer to **Table B-4**).

Phase 4—Post-Spill, Long-Term Recovery and Response

Wetlands serve a number of important ecological functions. For example, Louisiana's coastal wetlands support more than two-thirds of the wintering waterfowl population of the Mississippi Flyway (Louisiana Department of Wildlife and Fisheries, 2012). Therefore, loss of wetlands would also impact a significant portion of the waterfowl population. Another important ecological function of wetlands is their use as a nursery for estuarine-dependent species of fish and shellfish. Wetland loss would reduce the available nursery habitat.

The duration and magnitude of a spill resulting from a catastrophic blowout could result in high concentrations of oil that would result in long-term effects to wetland vegetation, including some plant mortality and loss of land. Silliman et al. (2012) found that after the *Macondo* well blowout and spill, oil coverage of Louisiana salt marshes was primarily concentrated on their seaward edges. Oil-driven plant death on the edges of these marshes more than doubled the rates of shoreline erosion, further driving marsh platform loss that is likely to be permanent. Eighteen months after the *Macondo* well blowout and spill, in previously oiled, noneroded areas, marsh grasses had largely recovered, and the elevated shoreline retreat rates observed at oiled sites had decreased to levels at reference marsh sites. Studies of impacted wetlands have demonstrated that wetlands can recover from the impacts of oil spills, but the recovery process varies from extremely slow in mangrove swamps (Burns et al., 1993 and 1994) to relatively rapid in grass-dominated marshes subject to in-situ burning of oil (Baustian et al., 2010).

Land loss caused by the oiling of wetlands would add to continuing impacts of other factors, such as hurricanes, subsidence, saltwater intrusion, and sea-level rise. The wetlands along the Gulf Coast have already been severely damaged by the 2005 and 2008 hurricane seasons, leaving the mainland less protected. It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 2,672 hectares/year (10 mi^2/year) over the next 50 years. Further, it was estimated that an additional net loss of 132,794 hectares (512 mi^2) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al., 2003). Barras (2006) indicated an additional 562 km^2 (217 mi^2) of land lost during the 2005 hurricane season. A catastrophic spill occurring nearshore would contribute further to this landloss. Following Hurricanes Katrina and Rita, another series of hurricanes (Gustav and Ike) made landfall along the Louisiana and Texas coasts in September 2008. Hurricane Gustav made landfall as a Category 2 storm near Cocodrie, Louisiana, pushing large surges of saline water into the fresh marshes and coastal swamps of Louisiana from Grand Isle westward. While Hurricane Gustav did not impact the quantity of wetlands that Hurricanes Katrina and Rita impacted, it did have a severe and continuing effect on the coastal barrier islands and the wetlands associated with backshore (back of the island) and foreshore (front of the island). While Hurricane Gustav affected the eastern portion of the Louisiana coast closer to Grand Isle and Houma, Hurricane Ike concentrated on Louisiana's western coast. The Texas coast received the brunt of Hurricane Ike where it made landfall slightly east of Galveston. The storm surge heavily eroded the dune systems and significantly lowered the beach elevations along the eastern portion of the Texas coast near Galveston and the Bolivar Peninsula. The erosion and wash-over associated with Hurricane Ike's tidal surge breeched beach ridges and opened the inland freshwater ponds and their associated wetlands to the sea. As a result of the four successive storms, the Louisiana and Texas coasts have lost protective elevations, barrier islands, and wetlands, and they now have the potential for transitioning to a less productive salt-marsh system in areas where fresh-marsh systems once existed. In addition, the loss of these protective elevations has increased the vulnerability of coastal wetlands to catastrophic oil-spill events.

A poorly executed oil cleanup can result in additional impacts. Aggressive onshore and marsh cleanup methods (such as removal by mechanized equipment, in-situ burning, marsh cutting, and foot entry into the marsh for manual removal) probably would not be initiated until the oil spill has been stopped. Depending on the marsh remediation methods used, further impacts to the wetlands may occur from cleanup activities. Boat traffic in marsh areas from the thousands of response vessels associated with a catastrophic spill would produce an incremental increase in erosion rates, sediment resuspension, and turbidity (i.e., an adverse but not significant impact to coastal wetland and seagrass habitats).

Overall Summary and Conclusion (Phases 1-4)

A spill from a catastrophic blowout could oil a few to several hundred acres of wetlands depending on the depth of inland penetration (Burdeau and Collins, 2010). This would vary from moderate to heavy oiling. Impacts to wetlands would vary according to the severity of the oiling. The duration and magnitude of the spill could result in severe oiling of wetlands in some areas, causing long-term effects to wetland vegetation, including some plant mortality and loss of land.

B.3.1.5. Seagrass Communities

Phase 1—Initial Event

There would likely be no adverse impacts to submerged vegetation as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because of the likely distance from the spill event to the nearest submerged vegetation beds.

Phase 2—Offshore Spill

There would likely be no adverse impacts to submerged vegetation as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill because of the likely distance from the spill event to the nearest submerged vegetation beds.

Phase 3—Onshore Contact

According to the most recent and comprehensive data available, approximately 500,000 hectares (1.25 million acres; 505,857 hectares) of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters and embayments of the northern Gulf of Mexico, and over 80 percent of this area is in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). Submerged vegetation distribution and composition depend on an interrelationship among a number of environmental factors that include water temperature, depth, turbidity, salinity, turbulence, and substrate suitability (Kemp, 1989; Onuf, 1996; Short et al., 2001). Marine seagrass beds generally occur in shallow, relatively clear, protected waters with predominantly sand bottoms (Short et al., 2001). Freshwater submerged aquatic vegetation (SAV) species occur in the low-salinity waters of coastal estuaries (Castellanos and Rozas, 2001). Seagrasses and freshwater SAV's provide important nursery and permanent habitat for sunfish, killifish, immature shrimp, crabs, drum, trout, flounder, and several other nekton species, and they provide a food source for species of wintering waterfowl and megaherbivores (Rozas and Odum, 1988; Rooker et al., 1998; Castellanos and Rozas, 2001; Heck et al., 2003; Orth et al., 2006). Further detail on this catastrophic OSRA run is contained in **Appendix C**.

If oil comes into areas with submerged beds, increased water turbulence from waves, storms, or vessel traffic could break apart the surface oil sheen and disperse some oil into the water column or mix oil with sediments that would settle and coat an entire plant. Coating of the plat from the oil and sediment mixture would cause reduced chlorophyll production and could lead to a decrease in vegetation (Teal and Howarth, 1984; Burns et al., 1994; Erftemeijer and Lewis, 2006). This coating situation also happens when oil is treated with dispersants because the dispersants break down the oil and it sinks into the water column (Thorhaug et al., 1986; Runcie et al., 2004). However, as reviewed in Runcie et al. (2004), oil mixed with dispersants has shown an array of effects on seagrass depending on the species and dispersant used. With a greater distance from shore, there is a greater chance of the oil being weathered by natural and mechanical processes by the time it reaches the nearshore habitat.

Depending on the species and environmental factors (e.g., temperature and wave action), seagrasses may exhibit minimal impacts, such as localized loss of pigmentation, from a spill; however, communities residing within the beds could accrue greater negative outcomes (den Hartog and Jacobs, 1980; Jackson et al., 1989; Kenworthy et al., 1993; Taylor et al., 2006). Community effects could range from either direct mortality due to smothering or indirect mortality from loss of food sources and habitat to a decrease in ecological performance of the entire system depending on the severity and duration of the spill event (Zieman et al., 1984).

Prevention and cleanup efforts could also affect the health of submerged vegetation communities (Zieman et al., 1984). Many physical prevention methods such as booms, barrier berms, and diversions can alter hydrology, specifically changing salinity and water clarity. These changes would harm certain species of submerged vegetation because they are tolerant to specific salinities and light levels (Zieman et al., 1984; Kenworthy and Fonesca, 1996; Frazer et al., 2006). With cleanup, there is increased boat and human traffic in these sensitive areas that generally are protected from this degree of human disturbance prior to the response. Increased vessel traffic would lead to elevated water turbidity and increased propeller scarring. While the elevated levels of water turbidity from vessels would be short-term and the possible damages from propellers could be longer, both events would be localized during the prevention and cleanup efforts (Zieman, 1976; Dawes et al., 1997).

Phase 4—Post-Spill, Long-Term Recovery and Response

According to the most recent and comprehensive data available, approximately 500,000 hectares (1.25 million acres; 505,857 hectares) of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters and embayments of the northern Gulf of Mexico, and over 80 percent of this area is in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). Submerged vegetation distribution and composition depend on an interrelationship among a number of environmental factors that include water temperature, depth, turbidity, salinity, turbulence, and substrate suitability (Kemp, 1989; Onuf, 1996; Short et al., 2001). Seagrasses and freshwater SAV's provide important nursery and permanent habitat for sunfish, killifish, immature shrimp, crabs, drum, trout, flounder, and several other nekton species, and they provide a food source for species of wintering waterfowl and megaherbivores (Rozas and Odum, 1988; Rooker et al., 1998; Castellanos and Rozas, 2001; Heck et al., 2003; Orth et al., 2006).

A source of potential long-term impacts to submerged beds from a catastrophic spill event is the possibility of buried or sequestered oil becoming resuspended after a disturbance, which would have similar effects as the original oiling event. This could occur in the event of hurricane impacts, which exacerbate the problem with numerous other short-terms stresses, such as turbidity, abrasion, breakage, uprooting SAV and seagrasses, and the alteration of bottom profiles and hydrology. Because different species have different levels of sensitivity to oil, it is difficult to compare studies and extrapolate what variables caused the documented differences in vegetation and community health (Thorhaug et al., 1986; Runcie et al., 2004). In general, studied seagrasses did not show significant negative effects from an oil spill (den Hartog and Jacobs, 1980; Kenworthy et al., 1993; Taylor et al., 2006; Taylor et al., 2007).

If bays and estuaries accrue oil, there is an assumption that there would be a decrease in seagrass cover and negative community impacts. Submerged vegetation serves important ecological functions. For example, seagrasses and freshwater SAV's provide important habitat and are a food source for a wide range of species in multiple life history stages (Castellanos and Rozas, 2001; Short and Coles, 2001;

Caldwell, 2003). Therefore, loss of submerged vegetation would adversely impact these species with a loss of valuable habitat and food.

Overall Summary and Conclusion (Phases 1-4)

Because of the likely distance of an initial catastrophic spill event to submerged vegetation communities, there would be no adverse impacts to submerged vegetation resulting from the initial event (Phase 1). Also, with regards to an offshore spill event, there would likely be no adverse impacts to submerged vegetation before the spill reaches shore (Phase 2). An estimated probability of oil contacting its coastline from the CPA example OSRA run can be found in **Appendix C** (Phase 3). It is assumed when these coastlines are contacted with oil, all associated habitat are considered oiled. If oil comes into areas with submerged beds, oil mixed with sediments or with dispersants could settle and coat an entire plant and could cause reduced chlorophyll production and could lead to a decrease in vegetation. Depending on the species and environmental factors (e.g., temperature and wave action), seagrasses may exhibit minimal impacts, such as localized loss of pigmentation, from an oil spill; however, communities residing within the beds could accrue greater negative outcomes. Increased vessel traffic from cleanup efforts would lead to elevated water turbidity and increased propeller scarring. A source of potential long-term impacts to submerged beds from a catastrophic spill event is the possibility of buried or sequestered oil becoming resuspended after a disturbance, which would have similar effects as the original oiling event (Phase 4). While there are impacts on submerged vegetation from an oiling event, the probabilities of an event to occur and contact coastlines are generally low and any impacts that can occur depend on a variety of factors (e.g., plant species, oil type, current environmental conditions, etc.). In general, studied seagrasses did not show significant negative effects from a spill (den Hartog and Jacobs, 1980; Kenworthy et al., 1993; Taylor et al., 2006 and 2007).

B.3.1.6. Live Bottoms (Pinnacle Trend and Low Relief)

The Gulf of Mexico has hard-bottom features upon which encrusting and epibenthic organisms attach on the continental shelf in water depths less than 300 m (984 ft). Live bottom features occur in the northeastern portion of the CPA and in the EPA. The Pinnacle Trend is located in the northeastern portion of the central Gulf of Mexico at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon. Live bottom (Pinnacle Trend) features are defined in NTL 2009-G39 as “small, isolated, low to moderate relief carbonate reefal features or outcrops of unknown origin or hard substrates exposed by erosion that provide area for the growth of sessile invertebrates and attract large numbers of fish.” Fish are attracted to outcrops that provide hard substrate for sessile invertebrates to attach. BOEM does not allow bottom-disturbing activities to occur within 30 m (98 ft) of any hard bottoms/pinnacles in 74 lease blocks in the CPA (each block is typically 3 mi x 3 mi).

Live bottom (low relief) features are defined in NTL 2009-G39 as “seagrass communities; areas that contain biological assemblages consisting of sessile invertebrates living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; and areas where hard substrate and vertical relief may favor the accumulation of turtles, fishes, or other fauna”. These features also include the reef communities like those found on the Florida Escarpment. BOEM has stipulations to protect these features from impacts, including bottom-disturbing activity. This chapter discusses the hard substrate, as seagrasses are covered in **Chapter B.3.1.5**.

Phase 1—Initial Event

A blowout from an oil well could result in a catastrophic spill event. A catastrophic blowout would result in released oil rapidly rising to the sea surface because all known reserves in the GOM have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. The oil would surface almost directly over the source location. However, if the oil is ejected under high pressure, micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil’s buoyancy (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsea plumes or sinking oil on particulates may contact live bottom features.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying many organisms within a few hundred meters of the wellhead. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. If a blowout were to occur close enough to a live bottom feature, suspended sediment may impact the organisms living on the feature.

A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the sediment.

The use of subsea dispersants would increase the exposure of offshore benthic habitats to dispersed oil droplets in the water column, as well as the chemicals used in the dispersants. The use of subsea dispersants is not likely to occur for seafloor blowouts outside the well casing.

Impacts to Live Bottom Features

Impacts that occur to benthic organisms on live bottom features as a result of a blowout would depend on the type of blowout, distance from the blowout, relief of the biological feature, and surrounding physical characteristics of the environment (e.g., turbidity). The distancing of bottom-disturbing activities from Pinnacle and live bottom, low-relief features helps to prevent blowouts in the immediate vicinity of a live bottom feature or its associated biota. Much of the oil released from a blowout would rise to the sea surface, therefore minimizing the impact to benthic communities by direct oil exposure. However, small droplets of oil that are entrained in the water column for extended periods of time may migrate into areas that have live bottom features. Although these small oil droplets will not sink themselves, they may attach to suspended particles in the water column and then be deposited on the seafloor (McAuliffe et al., 1975). The resultant long-term impacts, such as reduced recruitment success, reduced growth, and reduced coral or other epibenthic cover, as a result of impaired recruitment, are discussed in Phase 4 ("Post-Spill, Long-Term Recovery and Response"). Also, if the blowout were to occur beneath the seabed, suspension and subsequent deposition of disturbed sediment may smother localized areas of live bottom communities.

Following a catastrophic, subsurface blowout, benthic communities on a live bottoms exposed to large amounts of resuspended and then deposited sediments could be subject to sediment suffocation, exposure to resuspended toxic contaminants and to reduced light availability. Impacts to fauna found on hard bottoms as a result of sedimentation would vary based on species, the height to which the organism grows, degree of sedimentation, length of exposure, burial depth, and the organism's ability to clear the sediment. Impacts may range from sublethal effects (such as reduced or slower growth, alteration in form, and reduced recruitment and productivity) to suffocation and death (Rogers, 1990; Fucik et al., 1980).

The initial blowout impact would be greatest to communities located in clear waters that experience heavy sedimentation. The most sensitive organisms are typically elevated above soft sediments, making them less likely to be buried, and it is unlikely that corals would experience heavy sedimentation because they are located within Live Bottom (Low Relief) Stipulation blocks that distance bottom-disturbing activity from the features. None of the Live Bottom Stipulation blocks were included in the current proposed lease sale, farther distancing oil and gas activity from live bottoms. In addition, BOEM conducts case-by-case reviews of plans submitted by operators to ensure that the proposed activity will not impact sensitive seafloor features. It is possible, however, for some live bottoms to experience some turbidity or sedimentation impacts from a blowout if they are downstream of a current transporting sediment. Corals may experience discoloration or bleaching as a result of sediment exposure, although recovery from such exposure may occur within 1 month (Wesseling et al., 1999).

Initial impacts would be much less extreme in a turbid environment (Rogers, 1990). For example, the Pinnacle Trend community exists in a relatively turbid environment, starting just 65 km (37 mi) east of the mouth of the Mississippi River and trending to the northeast, and many low-relief live bottoms are frequently covered with a thin sand veneer that moves with waves and bottom currents, exposing and covering up areas with movement (Phillips et al., 1990; Gittings et al., 1992). Sediment from a blowout, if it occurred nearby, may have a reduced impact on these communities compared with an open-water reef community, as these organisms are more tolerant of suspended sediment (Gittings et al., 1992). Many of the organisms that predominate in this community also grow tall enough to withstand the sedimentation that results from their turbid environment or have flexible structures that enable the passive removal of sediments (Gittings et al., 1992). Those organisms that have a lesser relief could experience sedimentation, abrasion, and suffocation. However, many organisms present in the lower relief, live bottom habitat are motile, can burrow in the sediment, or have mechanisms for dealing with turbidity and can be tolerant of short-term high turbidity events. For example, bivalves can reduce their filtration rates if the suspended sediment concentrations become elevated and can reject excess sediment through pseudofeces (Clarke and Wilber, 2000). Many crustaceans are able to tolerate high levels of suspended sediment; for example, crabs and shrimp spend a portion of their lives in estuaries and nearshore waters that are turbid (Wilber et al., 2005). These organisms are also able to move away from turbid areas that have sediment concentrations that become too high (Clarke and Wilber, 2000; Wilber et al., 2005). Oysters, on the other hand, are not able to move away from turbidity, but they are tolerant of this environmental factor as they tend to live near the mouths of rivers that deposit sediment into their habitat (Wilber et al., 2005). Many of these organisms can also rapidly repopulate an area affected by sedimentation (Fucik et al., 1980).

A portion or the entire rig may sink to the seafloor as a result of a blowout. The benthic features and communities upon which the rig settles would be destroyed or smothered. Encrusting organisms would be crushed by a rig if it lands on a live bottom feature. A settling rig may suspend sediments, which may smother nearby benthic communities if the sediment is redeposited on sensitive features. The habitats beneath the rig may be permanently lost; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration if the hard substrate upon which they live was not physically destroyed. Destruction of a live bottom community by a sinking rig is highly unlikely because BOEM requires infrastructure to be distanced from live bottoms.

Phase 2—Offshore Spill

A spill from a shallow-water blowout could impact benthic communities on the continental shelf because of the blowout's proximity to these habitats. The scenario (**Table B-4**) for a catastrophic spill on the continental shelf is assumed to last 2-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana midrange paraffinic sweet crude oil could be released, which will float (API° >10). An anticipated 35,000 bbl of dispersant may be applied to the surface waters.

A spill from a deepwater blowout could also impact shelf communities if surface oil is transported to these areas. The scenario (**Table B-4**) for a catastrophic spill in deep water is assumed to last 4-6 months and to release 30,000-60,000 bbl per day. A total volume of 2.7-7.2 MMbbl of South Louisiana midrange paraffinic sweet crude oil will be released, which will float (API° >10). Oil properties may change as it passes up the well and through the water column, and it may become emulsified. An anticipated 33,000 bbl of dispersant may be applied to the surface waters and 16,500 bbl may be applied subsea. Weathering and dilution of the oil will also occur as it travels from its release point. It is unlikely that a subsurface plume from a deepwater blowout would impact shelf communities. The oil is anticipated to remain in deep water and to be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts to Live Bottom Features

Impacts from Surface Oil

Sensitive live bottom communities can flourish on hard bottoms in the Gulf of Mexico. The eastern Gulf of Mexico contains scattered, low-relief live bottoms, including areas of flat limestone shelf rock and the Pinnacle Trend area, located on the Mississippi Alabama continental shelf, which includes low- and high-relief features that are 60-120 m (197-394 ft) below the sea surface. The depth at which Pinnacles and most live bottom, low-relief features flourish below the sea surface helps to protect these habitats from a surface oil spill. Rough seas may mix the oil into subsurface water layers, where it may impact sessile biota. The longer the seas are rough, the greater the amount of oil from a surface slick would be mixed into the water column. Measurable amounts of oil have been documented to mix from the surface 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 oil is found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals and other benthic organisms (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985; Scarlett et al., 2005; Hemmer et al., 2010; George-Ares and Clark, 2000). Low-relief, live bottom habitats located in shallow coastal water may be at greater risk of surface oil mixing to the depth where their active growth occurs; however, because oil and gas activities currently take place far from the coastlines where nearshore live bottoms are located, the surface oil will be well dispersed and diluted by the time it reaches waters above the shallow live bottoms. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Impacts from Subsurface Oil

The presence of a subsurface oil plume on the continental shelf from a shallow-water blowout may affect benthic communities on live bottom features. A majority of oil released is expected to rise rapidly to the sea surface above the release point because of the specific gravity characteristics of the oil reserves in the GOM, thus not impacting sensitive benthic communities. If oil is ejected under high pressure, oil droplets may become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsurface plumes generated by high-pressure dissolution of oil may come in contact with live bottom habitats. A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column will become diluted or evaporated over time, reducing any localized transport to the seafloor (Vandermeulen, 1982). In addition, microbial degradation of the oil occurs in the water column so that the oil would be less toxic as it travels from the source (Hazen et al., 2010). However, a sustained spill may result in elevated exposure concentrations to benthic communities if the plume reaches them. The longer the spill takes to stop, the longer the exposure time and the higher the exposure concentration may be.

Live bottom, low-relief features have a greater chance of being impacted by subsea plumes than some Pinnacle features because currents may sweep around the larger features, as they do with topographic features (Rezak et al., 1983; McGrail, 1982). The lower relief live bottoms (including low-relief features in the Pinnacle Trend) may fall in the path of the plume because the feature is not large enough to divert a current. Low-level exposures of organisms to oil from a subsea plume may result in chronic or temporary impacts. For example, feeding activity or reproductive ability may be reduced when coral is exposed to low levels of oil; however, impacts may be temporary or unable to be measured over time. Experiments indicated that oil exposure reduced the normal feeding activity of coral, and oiled reefs produced smaller gonads than unoiled reefs, resulting in reproductive stress (Lewis, 1971; Guzmán and Holst, 1993). In addition, photosynthesis and growth may be reduced with oil exposure, and petroleum may be incorporated into coral tissue (Cook and Knap, 1983; Dodge et al., 1984; Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992). Sublethal responses of other marine invertebrates on live bottoms may result in population level changes (Suchanek, 1993) at concentrations as low as 1-10 ppb (Hyland and Schneider, 1976). Sublethal impacts may include reduced feeding rates, reduced ability to detect food, erratic movement, ciliary inhibition, tentacle retraction, reduced movement, decreased aggression, and altered respiration (Scarlett et al., 2005; Suchanek, 1993). Embryonic life stages of benthic organisms may experience toxic effects at lower levels than adult stages (Fucik et al., 1995; Suchanek, 1993; Beiras and Saco-Álvarez, 2006; Byrne, 1989).

It is unlikely that a subsurface plume from a deepwater blowout would impact live bottom shelf communities. The oil is anticipated to remain in deep water and be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts from Dispersed Oil

If dispersants are used at the sea surface, oil may mix into the water column. If applied subsea, they can travel with currents through the water, and they may contact or settle on sensitive features. Note that, as indicated above, a deepwater plume would not travel onto the continental shelf, but a plume formed on the continental shelf could impact live bottom features. If near the source, the dispersed oil could be concentrated enough to harm the community. If the oil remains suspended for a longer period of time, it would be more dispersed and present at lower concentrations. Reports on dispersant usage on surface oil indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing oil adhering to sediments and traveling to the seafloor (McAuliffe et al., 1981). There is very little information on the mixing and dispersion of subsea dispersants.

Dispersed oil reaching live bottoms in the Gulf of Mexico would be expected to occur at very low concentrations (<1 part per million [ppm]) (McAuliffe et al., 1981). Such concentrations would not be life threatening to larval or adult stages at this depth below the sea surface based on experiments conducted with benthic organisms. Any dispersed oil in the water column that comes in contact with live bottoms may evoke short-term negative responses by the organisms (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984; Scarlett et al., 2005; Renzoni, 1973).

The impact of dispersants on benthic organisms is dependent on the dispersant used, length of exposure, and the physical barriers the organism has to protect itself from the dispersant. Organisms with shells appear to be more tolerant of dispersants than those with only a tissue barrier (Scarlett et al., 2005). In addition, organisms that produce mucus, such as coral, have an elevated tolerance for oil exposure (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Concentrations of 100 ppm and 1,000 ppm oil plus dispersant in a ratio of 4:1 were necessary for oyster and mussel fertilization and development to become reduced when the larvae was exposed to the mixture (Renzoni, 1973). After 48 hours of exposure to dispersants, the blue mussel (*Mytilus edulis*) died at dispersant concentrations of 250 ppm, although reduced feeding rates were observed at 50 ppm (Scarlett et al., 2005). The snakelocks anemone (*Anemonia viridis*), which does not have a protective shell, was much more sensitive to dispersants. It retracted its tentacles and failed to respond to stimuli after 48 hours of exposure to 40 ppm dispersant (Scarlett et al., 2005). Corals exposed to dispersed oil showed mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, localized tissue rupture, and reduced photosynthesis (Wyers et al., 1986; Cook and Knap, 1983). Respiratory damage to organisms does not appear to be reversible; however, if the exposure is short enough, nervous system damage may be reversed and organisms may recover (Scarlett et al., 2005). Experiments using both anemones and corals showed recovery after exposure to dispersants (Scarlett et al., 2005; Wyers et al., 1986)

Concentrations used in historical experiments are generally much higher than the exposure that would occur in the field (Renzoni, 1973; George-Ares and Clark, 2000). Although historical experiments seem to indicate that the toxicity of oil increases with the addition of the dispersant, the toxicity of the oil actually remains the same as it was when it was not dispersed, but exposure increases due to the dispersed components of the oil (George-Ares and Clark, 2000). However, the increase of oil into the water column with the addition of dispersants is temporary, as the dispersed oil is more easily diluted with the surrounding water and biodegraded by bacteria (George-Ares and Clark, 2000). Therefore, concentrated dispersants are not anticipated to reach live bottoms, and any impacts that do occur should be sublethal and temporary.

Impacts from Oil Adhering to Sediments

BOEM's policy, described in NTL 2009-G39, prevents wells from being placed immediately adjacent to sensitive communities. In the event of a seafloor blowout, however, some oil could be carried to live bottoms as a result of oil droplets adhering to suspended particles in the water column. Oiled sediment that settles to the seafloor may affect organisms attached to hard-bottom substrates. Impacts may include reduced recruitment success, reduced growth, and reduced benthic cover as a result of impaired recruitment. Experiments have shown that the presence of oil on available substrate for larval coral settlement has inhibited larval metamorphosis and larval settlement in the area. Oil exposure also increased the number of deformed polyps after metamorphosis occurred (Kushmaro et al., 1997). In addition, exposure to oiled sediment has also been shown to reduce the growth rate of clams (Dow, 1975).

The majority of organisms exposed to sedimented oil, however, are anticipated to experience low-level concentrations because as oiled sediments settle to the seafloor they become widely dispersed. Many organisms on live bottoms will be able to protect themselves from low levels of oiled sediment that may settle out of the water column. Organisms with shells will not experience direct contact with the oil, and mobile organisms will be able to move away from areas where oiled sediment has accumulated. Coral may also be able to protect itself from low concentrations of sedimented oil that settles from the water column through mucus that will not only act as a barrier to protect coral from the oil in the water column but which also been shown to aid in the removal of oiled sediment on coral surfaces (Bak and Elgershuizen, 1976). In addition, because many organisms in live bottom habitats are tolerant of turbidity and sedimentation, slight addition of sediment to the area should not impact survival.

Impacts from Oil-Spill Response Activity

Oil-spill-response activity may also impact sessile benthic features. Booms anchored to the seafloor are sometimes used to control the movement of oil at the water surface. Boom anchors can physically impact sessile benthic organisms, especially when booms are moved around by waves (Tokotch, 2010). Vessel anchorage and decontamination stations set up during response efforts may also break or kill live bottoms that have unmapped locations if anchors are set on the habitat. Injury to live bottom habitat as a result of anchor impact may result in long-lasting damage or failed recovery. Effort should be made to keep vessel anchorage areas as far from sensitive benthic features as possible to minimize impact.

Drilling muds comprised primarily of barite may be pumped into a well to stop a blowout. If a "kill" is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on stipulations as described in NTL 2009-G39, a well should be far enough away from a Pinnacle feature to prevent extruded drilling muds from smothering sensitive benthic communities. However, if drilling muds were to travel far enough or high enough in the water column to contact a sensitive community, the fluid would smother the existing community. Burial may lead to the elimination of a live bottom community.

Phase 3—Onshore Contact

There would likely be no adverse impacts to live bottom features as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill because the live bottom features are located offshore.

Phase 4—Post-Spill, Long-Term Recovery and Response

Live bottoms exposed to large amounts of resuspended sediments following a catastrophic, subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light penetration. The greatest impacts would occur to communities that exist in clear water with very low turbidity, such as the live bottoms off Florida. The consequences of a blowout near one of these features could be long lasting, although the occurrence of a blowout near such sensitive communities is unlikely because of stipulations described in NTL 2009-G39, which distances bottom-disturbing activity from live bottom features. In addition, BOEM conducts case-by-case reviews of submitted plans and pipelines so that sensitive seafloor habitat is avoided. Impacts to a community in more turbid waters, such as those on the Mississippi-Alabama Shelf, would be greatly reduced, as the species are tolerant of suspended sediments, and recovery would occur quicker. Recovery time from sediment exposure would depend on the amount of sediment an organism was exposed to, if an entire population was demolished, and the extent of the loss.

Impacts may also occur from low-level or long-term oil exposure. This type of exposure has the potential to impact live bottom communities, resulting in impaired health. Long-term impacts such as reduced recruitment success, reduced growth, and reduced organism cover as a result of impaired recruitment may occur. Recovery may be fairly rapid from brief, low-level exposures, but it could be much longer if acute concentrations of oil contact organisms. Recovery time would then depend on recruitment from outside populations that were not affected by oiling.

Overall Summary and Conclusion (Phases 1-4)

A catastrophic spill on the continental shelf would have a greater impact on live bottom features than a deepwater spill. Surface oil from a deepwater spill would be weathered and diluted by the time it reaches the surface waters over live bottom features (if it ever reaches them), and it would be unlikely, except in shallow coastal waters, that it would mix to the depth of the live bottoms in concentrations that could cause toxicity. Subsea plumes formed in deep water would not travel onto the continental shelf because deep-sea currents do not travel up a slope.

A catastrophic blowout and spill on the continental shelf has a greater chance to impact live bottom features. If a blowout on the continental shelf occurs close enough to sensitive features, the organisms may be smothered by settling sediment that is displaced by the blowout. The farther a feature is from the blowout, the lower its chance of being covered with settling sediment or sediment upon which oil adhered. The distancing of oil and gas activity from live bottom features helps to prevent heavy sedimentation, as well as features being crushed by a sinking rig.

In most cases, the impacts from oil would be sublethal. Surface oil is not expected to mix to the zone of active growth, and any oil components that do reach that depth would be at sublethal concentrations. Subsea plumes may contact the live bottom features; however, because currents tend to travel around instead of over large seafloor features, the Pinnacle features should be protected from subsea plumes, while lower relief live bottoms may be impacted. The current oil and gas activity in the GOM, however, is distanced from low-relief live bottoms because no live bottom, low-relief blocks have been leased with the current proposed lease sales. Overall impacts of dispersed oil would be similar to subsea plumes. Spill response activity may impact low-relief, live bottom features if they are unmarked on nautical charts and vessels anchor on the features, but it is doubtful that a vessel would anchor on a marked Pinnacle feature.

Overall, a catastrophic spill would have a fairly low probability of impacting live bottom features because the bottom-disturbing activities of oil and gas activities are distanced from live bottom features within the Live Bottom Stipulation blocks, as described in NTL 2009-G39, and because BOEM conducts a case-by-case review of all plans to ensure that activities do not impact these seafloor features. In addition, the Live Bottom Stipulation blocks have not been leased as part of these proposed lease sales, creating farther distance between oil and gas activities and live bottoms. Also, live bottom features are protected by the limited mixing depth of surface oil compared with the depth of the live bottom features, currents sweeping around larger features, and the weathering and dispersion of oil that would occur with distance from the source as it travels toward the features. Low-relief features could have impacts from a blowout as their relief would not divert currents. In addition, the locations of these features are not all known so accidental anchor impacts may result in breakage of the features and possibly destruction. These low-relief features, however, would be protected by the regulated distance of current oil and gas activities, which increases the chance of oil becoming well dispersed before it reaches the features.

B.3.1.7. Topographic Features

The Gulf of Mexico has a series of topographic features (banks or seamounts) on the continental shelf in water depths less than 300 m (984 ft). Topographic features are isolated areas of moderate to high relief that provide habitat for hard-bottom communities of high biomass and moderate diversity. These features support prolific algae, invertebrate, and fish communities, and they provide shelter and food for large numbers of commercially and recreationally important fish. There are 37 named topographic features in the Gulf of Mexico with specific BOEM protections, including the Flower Garden Banks. BOEM has created “No Activity Zones” around topographic features in order to protect these habitats from disruption by oil and gas activities. A “No Activity Zone” is a protective perimeter drawn around each feature that is associated with a specific isobath (depth contour) surrounding the feature in which structures, drilling rigs, pipelines, and anchoring are not allowed. These “No Activity Zones” are areas where activity is prohibited based on BOEM’s policy. NTL 2009-G39 recommends that drilling should not occur within 152 m (500 ft) of a “No Activity Zone” of a topographic feature.

Potentially sensitive biological features (PSBF’s) are features that have moderate to high relief (8 ft [2 m] or higher), provide hard surface for sessile invertebrates, and attract fish, but they are not located within the “No Activity Zone” of topographic features. These features are frequently located near topographic features. No bottom-disturbing activities that may cause impact to these features are permitted.

Phase 1—Initial Event

A blowout from an oil well could result in a catastrophic spill event. A catastrophic blowout would result in released oil rapidly rising to the sea surface because all known reserves in the GOM have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. The oil would surface almost directly over the source location. However, if the oil is ejected under high pressure, micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy and slowing its rise to the surface (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsea plumes or sinking oil on particulates may contact topographic features.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying many organisms within a few hundred meters of the wellhead. Fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. If a blowout were to occur near a topographic feature, suspended sediment may impact the organisms living on the lower levels of the topographic feature (since water currents flow around the banks rather than traveling uphill).

A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the sediment.

The use of subsea dispersants would increase the exposure of offshore benthic habitats to dispersed oil droplets in the water column, as well as the chemicals used in the dispersants. The use of subsea dispersants is not likely to occur for seafloor blowouts outside the well casing.

Impacts to Topographic Features

Impacts that occur to benthic organisms on topographic features as a result of a blowout would depend on the type of blowout, distance from the blowout, relief of the biological feature, and surrounding physical characteristics of the environment (e.g., turbidity). The NTL 2009-G39 recommends the use of buffers to prevent blowouts in the immediate vicinity of a topographic feature or its associated biota. Much of the oil released from a blowout would rise to the sea surface, therefore minimizing the impact to benthic communities by direct oil exposure. However, small droplets of oil that are entrained in the water column for extended periods of time may migrate into No Activity Zones that surround the topographic feature. In addition, they may come in contact with PSBF's. Although these small oil droplets will not sink themselves, they may attach to suspended particles in the water column and then be deposited on the seafloor (McAuliffe et al., 1975). The resultant long-term impacts, such as reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment, are discussed in Phase 4 (Post-Spill, Long-Term Recovery and Response). Also, if the blowout were to occur beneath the seabed, suspension and subsequent deposition of disturbed sediment may smother localized areas of benthic communities, possibly including organisms within No Activity Zones or on PSBF's.

Benthic communities on a topographic feature or PSBF exposed to large amounts of resuspended and deposited sediments following a catastrophic, subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light availability. Impacts to corals as a result of sedimentation would vary based on coral species, the height to which the coral grows, degree of sedimentation, length of exposure, burial depth, and the coral's ability to clear the sediment. Impacts may range from sublethal effects such as reduced growth, alteration in form, and reduced recruitment and productivity to slower growth or death (Rogers, 1990). Corals may also experience discoloration or bleaching as a result of sediment exposure, although recovery from such exposure may occur within 1 month (Wesseling et al., 1999).

The initial blowout impact would be greatest to communities located in clear waters with little suspended sediment that experience heavy sedimentation as a result of the blowout. Reef-building corals are sensitive to turbidity and may be killed by heavy sedimentation (Rogers, 1990; Rice and Hunter, 1992). However, it is unlikely that reef-building corals would experience heavy sedimentation as a result of a blowout because drilling activity is not allowed near sensitive organisms in the No Activity Zones based on the lease stipulations as described in NTL 2009-G39. The most sensitive organisms are also typically elevated above soft sediments, making them less likely to be buried. The lower levels of topographic banks and the PSBF's, which are generally small features with only a few meters of relief, typically experience turbid conditions. Vigorous bottom currents (often generated by storms) frequently resuspend bottom sediments and bathe these features in turbid waters, which results in sedimentation. As a result, the organisms that live in this environment near the seafloor are those adapted to frequent sedimentation.

Initial impacts would be much less extreme in a turbid environment (Rogers, 1990). For example, the South Texas Banks exist in a relatively turbid environment (the Nepheloid Zone). They generally have lower relief than the farther offshore banks at the shelf edge, may have a sediment cover, and exhibit reduced biota. Sediment from a blowout, if it occurred nearby, may have a reduced impact on these communities compared with an open-water reef community, as these organisms are more tolerant of suspended sediment (Gittings et al., 1992). Many of the organisms that predominate in this community also grow tall enough to withstand the sedimentation that results from their turbid environment or have flexible structures that enable the passive removal of sediments (Gittings et al., 1992).

A portion or the entire rig may sink to the seafloor as a result of a blowout. The benthic features and communities upon which the rig settles would be destroyed or smothered. Encrusting organisms would be crushed by a rig if it lands on a topographic feature or PSBF. A settling rig may suspend sediments, which may smother nearby benthic communities if the sediment is redeposited on sensitive features. The habitats beneath the rig may be permanently lost; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration if the hard substrate upon which they live was not physically destroyed.

Phase 2—Offshore Spill

A spill from a shallow-water blowout could impact benthic communities on the continental shelf because of the blowout's proximity to these habitats. The scenario (**Table B-4**) for a catastrophic spill on the continental shelf is assumed to last 2-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana midrange paraffinic sweet crude oil could be released, which will float (API° >10). An anticipated 35,000 bbl of dispersant may be applied to the surface waters.

A spill from a deepwater blowout could also impact shelf communities if surface oil is transported to these areas. The scenario (**Table B-4**) for a catastrophic spill in deep water is assumed to last 4-6 months and to release 30,000-60,000 bbl per day. A total volume of 2.7-7.2 MMbbl of South Louisiana midrange paraffinic sweet crude oil will be released, which will float (API° >10). Oil properties may change as it passes up the well and through the water column, and it may become emulsified. An anticipated 33,000 bbl of dispersant may be applied to the surface waters and 16,500 bbl may be applied subsea. Weathering and dilution of the oil will also occur as it travels from its release point. It is unlikely that a subsurface plume from a deepwater blowout would impact shelf communities. The oil is anticipated to remain in deep water and be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts to Topographic Features

Impacts from Surface Oil

Sensitive reef communities flourish on topographic features and PSBF's in the Gulf of Mexico. Their depth below the sea surface helps to protect these habitats from a surface oil spill. Rough seas may mix the oil into subsurface water layers, where it may impact sessile biota. The longer the amount of time the seas are rough, the greater the amount of oil from a surface slick would be mixed into the water column. Measurable amounts of oil have been documented to mix from the surface down to a 10-m (33-ft) water depth, although modeling exercises have indicated such oil may reach a water depth of 20 m (66 ft). At this depth, however, 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).

None of the topographic features or PSBF's in the GOM are shallower than 10 m (33 ft), and only the Flower Garden Banks are shallower than 20 m (66 ft). Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Impacts from Subsurface Oil

The presence of a subsurface oil plume on the continental shelf from a shallow-water blowout may affect benthic communities on topographic features and PSBF's. A majority of the oil released is expected to rise rapidly to the sea surface above the release point because of the specific gravity characteristics of the oil reserves in the GOM, thus not impacting sensitive benthic communities. If the oil is ejected under high pressure, oil droplets may become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy and slowing its rise to the surface (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsurface plumes generated by high-pressure dissolution of oil may come in contact with topographic features and PSBF's. A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column will become diluted or evaporated over time, reducing any localized transport to the seafloor (Vandermeulen, 1982). In addition, microbial degradation of the oil occurs in the water column so that the oil would be less toxic as it travels from the source (Hazen et al., 2010). However, a sustained spill may result in elevated exposure concentrations to benthic communities if the plume reaches them. The longer the spill takes to stop, the longer the exposure time and higher the exposure concentration may be.

The PSBF's have a greater chance of being impacted by subsea plumes than topographic features because currents tend to sweep around topographic features (Rezak et al., 1983; McGrail, 1982). The lower relief PSBF's may fall in the path of the plume because the feature is not large enough to divert a current. Low-level exposures of corals to oil from a subsea plume may result in chronic or temporary impacts. For example, feeding activity or reproductive ability may be reduced when coral is exposed to low levels of oil; however, impacts may be temporary or unable to be measured over time. Experimental simulations of exposure indicated that normal feeding activity of *Porites porites* and *Madracis asperula* were reduced when exposed to 50 ppm oil (Lewis, 1971). In addition, reefs of *Siderastrea siderea* that were oiled in a spill produced smaller gonads than unoiled reefs, resulting in reproductive stress (Guzmán and Holst, 1993).

Elevated concentrations of oil may be necessary to measure reduced photosynthesis or growth in corals. Photosynthesis of the zooxanthellae in *Diplora strigosa* exposed to approximately 18-20 ppm crude oil for 8 hours was not measurably affected, although other experiments indicate that photosynthesis may be impaired at higher concentrations (Cook and Knap, 1983). Measurable growth of *Diploria strigosa* exposed to oil concentrations up to 50 ppm for 6-24 hours did not show any reduced growth after 1 year (Dodge et al., 1984).

Corals exposed to subsea oil plumes may incorporate petroleum hydrocarbons into their tissue. Records indicate that *Siderastrea siderea*, *Diploria strigosa*, and *Montastrea annularis* accumulate oil from the water column and incorporate petroleum hydrocarbons into their tissues (Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992). Most of the petroleum hydrocarbons are incorporated into the coral tissues, not their mucus (Knap et al., 1982). However, hydrocarbon uptake may also modify lipid ratios of coral (Burns and Knap, 1989). If lipid ratios are modified, mucus synthesis may be impacted, adversely affecting the coral's ability to protect itself from oil through mucus production (Burns and Knap, 1989).

It is unlikely that a subsurface plume from a deepwater blowout would impact shelf communities. The oil is anticipated to remain in deep water and be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts from Dispersed Oil

If dispersants are used at the sea surface, oil may mix into the water column, or if applied subsea, they can travel with currents through the water and may contact or settle on sensitive features. Note that, as indicated above, a deepwater plume would not travel onto the continental shelf, but a plume formed on the continental shelf could impact topographic features and PSBF's. If located near the source, the dispersed oil could be concentrated enough to harm the community. If the oil remains suspended for a longer period of time, it would be more dispersed and exist at lower concentrations. Reports on dispersant usage on surface oil indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing oil adhering to sediments and traveling to the seafloor (McAuliffe et al., 1981). There is very little information on the behavior of subsea dispersants.

Dispersed oil reaching the topographic features and PSBF's in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981). Such concentrations would not be life threatening to larval or adult stages at the depth of the features based on experiments conducted with coral. Any dispersed oil in the water column that comes in contact with corals may evoke short-term negative responses by the organisms (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Reductions in feeding and photosynthesis could occur in coral exposed to dispersed oil. Short-term, sublethal responses of *Diploria strigosa* were reported after exposure to dispersed oil at a concentration of 20 ppm for 24 hours. Although concentrations in this experiment were higher than what is anticipated for dispersed oil at depth, effects exhibited included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, and localized tissue rupture (Wyers et al., 1986). Normal behavior resumed within 2 hours to 4 days after exposure (Wyers et al., 1986). *Diploria strigosa* exposed to dispersed oil (20:1, oil:dispersant) showed an 85 percent reduction in zooxanthellae photosynthesis after 8 hours of exposure to the mixture (Cook and Knap, 1983). However, the response was short term, as recovery occurred between 5 and 24 hours after exposure and return to clean seawater. Investigations 1 year after *Diploria strigosa* was exposed to concentrations of dispersed oil between 1 and 50 ppm for periods between 6 and 24 hours did not reveal any impacts to growth (Dodge et al., 1984).

Historical studies indicate dispersed oil to be more toxic to coral species than oil or dispersant alone. The greater toxicity may be a result of an increased number of oil droplets caused by the use of dispersant, resulting in greater contact area between oil, dispersant, and water (Elgershuizen and De Kruijf, 1976). The dispersant causes a higher water-soluble amount of oil to contact the cell membranes of the coral (Elgershuizen and De Kruijf, 1976). The mucus produced by coral, however, can protect the organism from oil. Both hard and soft corals have the ability to produce mucus, and mucus production has been shown to increase when corals are exposed to crude oil (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Dispersed oil, however, which has very small oil droplets, does not appear to adhere to coral mucus, and larger untreated oil droplets may become trapped by the mucus barrier (Knap, 1987; Wyers et al., 1986). However, entrapment of the larger oil droplets may increase the coral's long-term exposure to oil if the mucus is not shed in a timely manner (Knap, 1987; Bak and Elgershuizen, 1976). Additionally, more recent field studies, using more realistic concentrations of dispersants did not result in the toxicity historically reported (Yender and Michel, 2010).

Although historical studies indicated dispersed oil may be more toxic than untreated oil to corals during exposure experiments, untreated oil may remain in the ecosystem for long periods of time, while dispersed oil does not (Baca et al., 2005; Ward et al., 2003). Twenty years after an experimental oil spill in Panama, oil and impacts from untreated oil were still observed at oil treatment sites, but no oil or impacts were observed at dispersed oil or reference sites (Baca et al., 2005). Long-term recovery of the coral at the dispersed oil site had already occurred as reported in a 10-year monitoring update, and the site was not significantly different from the reference site (Ward et al., 2003).

Impacts from Oil Adhering to Sediments

BOEM's policy, as described in NTL 2009-G39, prevents wells from being placed immediately adjacent to sensitive communities. In the event of a seafloor blowout, however, some oil could be carried to topographic features or PSBF's as a result of oil droplets adhering to suspended particles in the water column. Oiled sediment that settles to the seafloor may affect organisms attached to hard-bottom substrates. Impacts may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. Experiments have shown that the presence of oil on available substrate for larval coral settlement has inhibited larval metamorphosis and larval settlement in the area. An increase in the number of deformed polyps after metamorphosis also took place because of exposure to oil (Kushmaro et al., 1997).

The majority of organisms exposed to sedimented oil, however, are anticipated to experience low-level concentrations because as the oiled sediments settle to the seafloor they are widely distributed. Coral may also be able to protect itself from low concentrations of sedimented oil that settles from the water column. Coral mucus may not only act as a barrier to protect coral from the oil in the water column, but it has also been shown to aid in the removal of oiled sediment on coral surfaces (Bak and Elgershuizen, 1976). Coral may use a combination of increased mucus production and the action of cilia to rid themselves of oiled sediment (Bak and Elgershuizen, 1976).

Impacts from Oil-Spill-Response Activity

Oil-spill-response activity may also impact sessile benthic features. Booms anchored to the seafloor are sometimes used to control the movement of oil at the water surface. Boom anchors can physically impact corals and other sessile benthic organisms, especially when booms are moved around by waves (Tokotch, 2010). Vessel anchorage and decontamination stations set up during response efforts may also break or kill PSBF's if their location is unmapped and anchors are set on the features. Injury to coral reefs as a result of anchor impact may result in long-lasting damage or failed recovery (Rogers and Garrison, 2001). Effort should be made to keep vessel anchorage areas as far from sensitive benthic features as possible to minimize impact.

Drilling muds comprised primarily of barite may be pumped into a well to stop a blowout. If a "kill" is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on stipulations as described in NTL 2009-G39, a well should be far enough away from a topographic feature to prevent extruded drilling muds from smothering sensitive benthic communities. However, if drilling muds were to travel far enough or high enough in the water column to contact a sensitive community, the fluid would smother the existing community. Experiments indicate that corals perish faster when buried beneath drilling mud than when buried beneath carbonate sediments (Thompson, 1980). Burial may lead to the elimination of a live bottom community.

Phase 3—Onshore Contact

There would likely be no adverse impacts to topographic features and PSBF's as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill because the topographic features and PSBF's are located offshore.

Phase 4—Post-Spill, Long-Term Recovery and Response

Topographic features and PSBF's exposed to large amounts of resuspended sediments following a catastrophic, subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light penetration. The greatest impacts would occur to communities that exist in clear water with very low turbidity. The consequences of a blowout along, directly on, or near one of these features could be long lasting, although the occurrence of a blowout near such sensitive communities is unlikely because of stipulations described in NTL 2009-G39, which prevents drilling activity near sensitive hard-bottom habitats. Impacts to a community in more turbid waters, such as the South Texas Banks, would be greatly reduced, as the species on these features are tolerant of suspended sediments, and recovery would occur quicker.

Impacts may also occur from low-level or long-term oil exposure. This type of exposure has the potential to impact reef communities, resulting in impaired health. Recovery may be fairly rapid from brief, low-level exposures, but it could be much longer with acute concentrations or long-term exposure to oil, such as in observations from Panama where untreated oil remained in the ecosystem for long periods of time, inhibiting coral recovery (Baca et al., 2005; Ward et al., 2003). Recovery time would therefore depend on recruitment from outside populations that were not affected by oiling and residence time of oil in an ecosystem.

Overall Summary and Conclusion (Phases 1-4)

A catastrophic spill on the continental shelf would have a greater impact on topographic features and PSBF's than a deepwater spill. Surface oil from a deepwater spill would be weathered and diluted by the time it reaches the surface waters over topographic features and PSBF's (if it ever reaches them), and it would be unlikely that it would mix to the depth of active growth in concentrations that could cause toxicity. Subsea plumes formed in deepwater would not travel onto the continental shelf because deep-sea currents do not travel up a slope.

A catastrophic blowout and spill on the continental shelf has a greater chance to impact topographic features and PSBF's. If the blowout occurs close enough to sensitive features, the organisms may be smothered by settling sediment that was displaced by the blowout. The farther the feature is from the blowout, the less its chance of being covered with settling sediment or sediment upon which oil adhered. In addition, distancing oil and gas activities from topographic features prevents the settlement of a sinking rig on top of a topographic feature, although it may destroy a PSBF.

In most cases, impacts from oil would be sublethal. Surface oil is not expected to mix to the zone of active growth, and any oil components that do reach that depth would be in sublethal concentrations. Subsea plumes may contact the features; however, because currents tend to travel around, instead of over, topographic features, the topographic features should be protected from subsea plumes, while lower relief PSBF's may be impacted. Overall impacts of dispersed oil would be similar to subsea plumes. Spill response activity should not impact topographic features because it is unlikely that vessels would anchor on the features, but they could anchor on unmapped, lower relief PSBF's.

Overall, a catastrophic spill would have a low probability of impacting topographic features because of the distancing requirements included in leases, as described in NTL 2009-G39, of oil and gas activities from topographic features, the depth of mixing of surface oil compared with the depth of the active growing zone, currents that sweep around the topographic features, and the weathering and dispersion of oil that would occur with distance from the source as it travels toward the features. The PSBF's could have greater impacts from a blowout as oil and gas activities are not as far distanced from them as topographic features; they have a lower relief than topographic features, which would not divert currents; and the locations of these features are not all known so accidental anchor impacts may result in breakage of the features and possibly destruction. The PSBF's would, however, have similar protection as for topographic features from surface oil.

B.3.1.8. Sargassum *Communities*

Pelagic *Sargassum* algae is a floating brown algae that occurs in all parts of the GOM throughout the year. It has a seasonal cycle so that its abundance greatly increases spring through fall, when it is carried by water currents around the south of Florida and then up the east coast (Gower and King, 2011). It occurs in patches, floating on and near the sea surface. Wind and water currents commonly drive it into long lines or windrows; when conditions are turbulent, it becomes more scattered and mixed into the upper water column. A key to understanding impacts to *Sargassum* is that the algae is ubiquitous and occurs in scattered patches in the very top part of the water column. *Sargassum* also provides habitat for pelagic species, including fish, invertebrates, and sea turtles.

Phase 1—Initial Event

During the initial phase of a catastrophic blowout, impacts may include disturbance of sediments, destruction of the drilling rig, release of oil and natural gas (methane), and emergency response efforts. This chapter deals with the immediate effects of a blowout that would be located at least 3 nmi (3.5 mi; 5.6 km) from shore.

Since *Sargassum* is a floating pelagic (open ocean) algae, it would only be affected by impacts that occur in the top-most part of the water column. In deep water (≥ 300 m, 984 ft), sediment disturbed by the blowout would not affect *Sargassum* because the sediment would not reach the surface waters. However, in shallow water, sediment from a blowout could have minor effects on *Sargassum* algae in the immediate vicinity. The sediment would have little effect on the algae itself, producing only slight, temporary silting that could reduce photosynthesis. If the sediment is contaminated with oil, then the oil could have adverse effects on the algae. Depending on the severity of oiling, the algae could be damaged or destroyed; but this would only affect the algae in the local vicinity of the blowout. Sediment and oil would have a more acute effect on the associated invertebrate, fish, and sea turtle community that utilizes the habitat of the *Sargassum*. Impacts to these organisms may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003).

Destruction of the oil drilling rig and associated equipment could have an acute effect on patches of *Sargassum* algae that happen to be caught in the structure (if it sinks) or destroyed by fuel leaks and possible fire on the sea surface. This could destroy local patches of *Sargassum*, but it would have no measurable effect on the *Sargassum* community as a whole.

The release of oil during the initial blowout event would be expected to cover local patches of *Sargassum* algae with oil, destroying the algae and associated organisms. Methane gas may also bathe local patches of algae as it rises through the sea surface; it would have little effect on the algae itself but may poison associated organisms. The initiation of oil and gas release (as defined for this phase) at the site of the blowout event would affect only local patches of *Sargassum*, but it would have no measurable effect on the *Sargassum* community as a whole.

Emergency response activities would have minor impacts to *Sargassum* algae that comes in contact with vessels. This is mostly the simple impingement of the algae on the ships' water intake screens, including water that may be pumped in fire-fighting efforts. This minor and local effect would have no measurable effect on the *Sargassum* community as a whole.

Phase 2—Offshore Spill

During the second phase of a catastrophic blowout, the major impact of concern is the release of oil and methane over time. Response efforts may produce additional minor impacts to *Sargassum*. This chapter deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

Since *Sargassum* is a floating pelagic (open ocean) algae, it would be affected by impacts that occur in the top-most part of the water column. This makes *Sargassum* habitat particularly susceptible to damage from offshore oil spills. Oceanographic processes that concentrate *Sargassum* into mats and rafts would also concentrate toxic substances. Therefore, it may be assumed that *Sargassum* would be found in areas where oil, dispersants, and other chemicals have accumulated following a catastrophic spill. Oil spreads on the sea surface to form extremely thin layers (0.01-0.1 micrometers) that cover large areas (MacDonald et al., 1996). Since *Sargassum* is ubiquitous in surface waters of the GOM, oil spreading on the sea surface can be expected to coincide with floating mats of the algae. The larger the quantity of spill and the longer it flows, the larger the area of sea surface it would cover. A catastrophic spill would cover a large area and result in impacts to a large quantity of *Sargassum* algae. For example, *Macondo* well oil spill covered up to one-third of the northern GOM (McCrea and Pauly, 2011; USDOC, NMFS, 2011a) and may have affected about one-third of the *Sargassum* algae in the northern GOM at the time.

The severity of oiling to *Sargassum* depends largely on physical conditions. Factors include the quantity of oil at a particular launch point and its physical state, distance from the source, weather conditions, and the possible use of dispersants. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Obviously, more oil leads to increased oiling, but the physical state of the oil changes as it weathers, biodegrades, dissipates, and emulsifies over time and distance. Storms can mix oil into the water column (expected maximum of 10-20 m [33-66 ft]; Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985; Scarlett et al., 2005; Hemmer et al., 2010; George-Ares and Clark, 2000), possibly increasing its contact with *Sargassum* as it also mixes the *Sargassum* into the water column. However, when storms are not mixing the oil, they are also not mixing the *Sargassum*, so the *Sargassum* would float near the sea surface, just as the oil would. Convergence zones, places in the ocean where strong opposing currents meet, would collect both oil and *Sargassum*. Sea turtles, especially post-hatchlings and juveniles, use these areas for food and cover. Witherington et al. (2012) surveyed sea turtles in the eastern Gulf of Mexico and Atlantic Ocean off Florida and found that 89 percent of the turtles documented were observed within 1 m (3 ft) of floating *Sargassum*. The use of dispersants on surface oil slicks could increase the exposure of *Sargassum* to oil by promoting mixing of oil into the upper few meters of the water column. This also promotes the dispersion of oil, speeding its decline toward low concentrations that would be less toxic. Regardless, any exposure that is enough to cause visible oiling can be expected to have significant detrimental effects on the organisms associated with *Sargassum* and, likely, effects on the *Sargassum* itself. Heavy oiling of *Sargassum* near the source of the spill would destroy the affected algae. Very light exposure far from the oil source may have little effect.

The specific effects of oil on *Sargassum* depend on the severity of oiling. High to moderate levels of oiling would likely cause complete mortality. Low levels of exposure may result in a range of sublethal effects to the algae and its associated community. There are no published studies of the effects of oil on *Sargassum* or its associates, but numerous studies of similar organisms in benthic habitats can suggest expected results. Sublethal responses in organisms associated with *Sargassum* may occur at concentrations as low as 1-10 ppb (Hyland and Schneider, 1976). Rogers (1990) documented impacts such as reduced growth, alteration in form, and reduced recruitment and productivity. Other sublethal impacts may include reduced feeding rates, reduced ability to detect food, erratic movement, ciliary inhibition, tentacle retraction, reduced movement, decreased aggression, and altered respiration (Scarlett et al., 2005; Suchanek, 1993). Embryonic life stages of organisms may experience toxicity at lower levels than the adult stages (Fucik et al., 1995; Suchanek, 1993; Beiras and Saco-Álvarez, 2006; Byrne, 1989). The algae itself would be less sensitive than many of its associates, since the algae produces oils of its own and has a waxy coating that may protect it from physical oiling.

Response efforts aimed at removing oil from the affected area would have minor impacts on *Sargassum* algae as well. Response vessels would impinge a small amount of the algae on their propellers and cooling-water intakes. Cleanup processes such as booming, skimming, and in-situ burning would also trap and destroy patches of *Sargassum*; however, these activities would take place in areas of high concentration of surface oil, where *Sargassum* would likely be destroyed by oil contamination even if the cleanup activity were absent.

Phase 3—Onshore Contact

This third phase of a catastrophic blowout focuses on the approach of oil to the shoreline. This involves the possible oiling of coastal resources including beaches, wetlands, SAV and seagrasses, the shallow seafloor, and any resources drifting in the water column (e.g., *Sargassum*). Response efforts can produce additional serious impacts.

There would likely be little additional impact to pelagic *Sargassum* algae as oil approaches a shoreline. Since both the algae and surface oil approaching shore would be guided by the same forces (wind and water currents), they would likely be already traveling together, with the algae already contaminated. Once it is onshore, the *Sargassum* would die, regardless of oil contamination. *Sargassum* that washes ashore has some value to the ecosystem as it provides food and shelter for some organisms as it decays. This value would be mostly lost if the *Sargassum* is oiled when it reaches shore.

Phase 4—Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both, the natural rate of recovery and the persistence of oil in natural habitats over time determine the long-term effects. Contaminants biodegrade over time, but they may become sequestered as inert forms (e.g., buried in sediment) until disturbed (by storms) and re-activated, producing renewed impacts.

Sargassum algae has a yearly seasonal cycle of growth and a yearly cycle of migration from the GOM to the western Atlantic. A catastrophic spill could affect a large portion of the annual crop of the algae. A large event, such as the *Macondo* well blowout and spill, could reduce the standing crop of *Sargassum* in the GOM and subsequently in the western Atlantic. This could have a cascading effect down current (in the Atlantic) that would stress the cycles of other organisms that depend on the *Sargassum* habitat. However, the effect can be expected to diminish with remoteness from the direct impacts of the spill, i.e., the algae community itself would be most affected, with lesser effects on organisms that utilize the habitat as a nursery, for feeding, as shelter, or other purposes.

While a large spill event could affect a large portion of the standing crop of *Sargassum*, several factors contribute to the quick recovery of the habitat. *Sargassum* algae is predominately found in the open-ocean pelagic habitat. Once the spill event subsides, the pelagic habitat would quickly regain its typically very high water quality. The pelagic habitat far from shore is also far from land-based sources of pollution. Only part of the *Sargassum* stocks would be affected; algae not affected by the spill event would continue to grow normally and repopulate the habitat. Since *Sargassum* has a seasonal cycle of growth in the summer and reduction in the winter, populations in the winter following a catastrophic event may be similar to populations of any other year. Relatively small populations survive each winter, subsequently repopulating the habitat each year. With this pattern, recovery from the effects of a catastrophic event is expected within 1-2 growing seasons.

Overall Summary and Conclusion (Phases 1-4)

Pelagic *Sargassum* algae is one of the most likely habitats to be affected by a catastrophic offshore oil spill; however, because of its ubiquitous distribution and seasonal cycle, recovery is expected within 1-2 years. *Sargassum* algae floats on and near the sea surface and occurs in patches that can be collated into windrows by wind and water currents. Oil from a spill offshore would accumulate in the same waters, making it inevitable that some patches of *Sargassum* would be severely affected.

The initial catastrophic event (Phase 1) could destroy *Sargassum* patches in the immediate vicinity of the accident. Impingement, fire, and the initial concentrated spillage of oil and fuels would destroy local patches. Sediments disturbed by the accident would only affect *Sargassum* if the event occurred in shallow waters.

The duration of the spill event (Phase 2) would have the most effect on floating *Sargassum* algae. Patches of algae within the entire coverage of the oil slick would be subject to severe damage and death. Algae in areas farther from the spill, receiving lower level impacts, may still suffer damage, especially the sensitive invertebrate and fish communities associated with the habitat. Efforts to remove the oil could gather *Sargassum* with the oil, but these algae patches would likely be destroyed by the oil anyway since the collection activities would occur in areas of concentrated oil.

As oil approaches shore (Phase 3), impacts to floating *Sargassum* algae would not increase much, as the algae would likely already be exposed to the oil since wind and water currents drive both the algae and the oil.

The recovery of floating *Sargassum* algae (Phase 4) may occur within 1-2 years because the algae has a yearly cycle of subsidence and re-growth. The pelagic habitat would quickly regain its high level of water quality after the cessation of a spill. Not all of the *Sargassum* habitat would be affected, even by a catastrophic spill; healthy algae would continue to grow and replenish the population. Within 1-2 years, the *Sargassum* algae community may have completely recovered from the impacts of a catastrophic spill.

B.3.1.9. Chemosynthetic Deepwater Benthic Communities

Deepwater benthic communities of the Gulf of Mexico include soft bottom, chemosynthetic, and coral habitats. Deep water, for ecology in the GOM, is defined as water depths over 300 m (984 ft) because chemosynthetic communities and *Lophelia* coral habitats have not been found in waters shallower than these depths. The possible impacts to these benthic communities from a catastrophic blowout depend on the location and the nature of the event.

Phase 1—Initial Event

During the initial phase of a catastrophic blowout, impacts may include the disturbance of sediments, destruction of the drilling rig, release of oil and natural gas (methane), and emergency response efforts. This chapter deals with the immediate effects of a blowout located at least 3 nmi (3.5 mi; 5.6 km) from shore.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying many organisms within a few hundred meters of the wellhead. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. If a blowout were to occur close enough to a chemosynthetic community, suspended sediment may impact the organisms. Restrictions described in NTL 2009-G40 require drilling to be removed at least 610 m (2,000 ft) from possible chemosynthetic communities. During a blowout, sediment may become contaminated with oil and subsequently deposit that oil down-current from the source. The highest concentrations of contamination would be nearest the well, and concentrations would diminish with distance. A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the sediment.

Destruction of the oil drilling rig and associated equipment could have an acute effect on any chemosynthetic communities caught under the direct impact of the equipment when it falls to the seafloor. However, the restrictions described in NTL 2009-G40 require drilling locations to be 610 m (2,000 ft) from any possible indications of chemosynthetic communities, reducing the possibility that a rig would settle directly on sensitive habitat.

A catastrophic blowout would likely result in released oil rapidly rising to the sea surface because typical reserves in the GOM have specific gravity characteristics that are much lighter than water (refer to **Chapter 3.2.1.3** of this Supplemental EIS; Environment Canada, 2011; Trudel et al., 2001). The oil would surface almost directly over the source location. Oil floating to the sea surface would be effectively removed from affecting chemosynthetic communities on the seafloor. Even oil treated with chemical dispersants on the sea surface would not be expected to have widespread impacts to deepwater communities. Reports on dispersant usage on surface oil indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a; Lewis and Aurand, 1997). Lubchenco et al. (2010) reports that chemically dispersed surface oil from the *Macondo* well blowout and oil spill remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. However, if the oil is ejected under high pressure, micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). Upward movement of oil may also be reduced if methane mixed with the oil is dissolved into the water column, reducing the buoyancy of the oil/gas stream (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010a). It is unlikely that any chemosynthetic community would be affected by the initial stage of a catastrophic event due to the required separation of drilling activities from sensitive habitats, because released oil would rise rapidly to a level above the habitat, and because surface oil would not mix to the depths of the chemosynthetic communities. The required separation distance would also allow for a subsea plume to mix with the surrounding water and become diluted before it reached a deepwater community.

Phase 2—Offshore Spill

During the second phase of a catastrophic blowout, the major impact of concern is the release of oil and methane over time. Response efforts may produce additional impacts. This chapter deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

A spill resulting from a catastrophic blowout in deep water has the potential to impact offshore benthic communities; however, it is not likely that deepwater benthic communities would be affected by a spill from a shallow-water blowout. Although subsurface plumes can be generated when oil is ejected under high pressure or dispersants are used subsea, a majority of the oil originating from a seafloor blowout in deep water is expected to rise rapidly to the sea surface. Upward movement of the oil may also be reduced if methane mixed with the oil is dissolved into the water (Adcroft et al., 2010). A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column would become diluted over time, reducing transport to the seafloor (Vandermeulen, 1982). Concentrations of dispersed and dissolved oil in the *Macondo* well blowout and spill subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010; Lubchenco et al., 2010). In addition, microbial degradation of oil occurs in the water column rendering oil less toxic when it contacts the seafloor (Hazen et al., 2010). Oil can precipitate to the seafloor by adhering to other particles, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil would also reach the seafloor through planktonic consumption and associated excretion, which is distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). These mechanisms would result in a wide distribution of small amounts of oil. Throughout these processes, oil would be biodegraded from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010).

A sustained spill may result in elevated exposure concentrations to chemosynthetic features if a subsea oil plume contacts them directly. Dispersed oil is mixed with water, and its movement is then dictated by water currents and the physical, chemical, and biodegradation pathways. BOEM's policy (refer to NTL 2009-G39) prevents wells from being placed immediately adjacent to sensitive communities; however, in the event of a seafloor blowout, some oil could be carried to chemosynthetic communities by subsea plumes. Impacts may include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment. Concentrated oil plumes reaching chemosynthetic communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. The longer the oil remains suspended in the water column, the more dispersed, less concentrated, and more biodegraded it would become. Depending on how long oil remained suspended in the water column, it may be thoroughly degraded by biological action before contacting the seafloor (Hazen et al., 2010; Valentine et al., 2010). Biodegradation rates in cold, deepwater environments are not well understood at this time. In general, potential impacts to chemosynthetic communities would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. While a few patch habitats may be affected, the Gulfwide ecosystem of chemosynthetic communities would be expected to suffer no significant effects.

Drilling muds comprised primarily of barite may be pumped into a well to stop a blowout. If a "kill" is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on stipulations as described in NTL 2009-G40, a well should be far enough away from a chemosynthetic community to prevent extruded drilling muds from smothering sensitive benthic communities.

Phase 3—Onshore Contact

The third phase of a catastrophic blowout focuses on the approach of oil to the shoreline. This involves the possible oiling of coastal resources including beaches, wetlands, SAV and seagrasses, the shallow seafloor, and any resources drifting in the water column. Response efforts can produce additional serious impacts. There would be no additional adverse impacts to chemosynthetic communities in deep water as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill because the chemosynthetic communities are located offshore in deep water (>300 m, 610 ft).

Phase 4— Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both the natural rate of recovery and the persistence of oil in natural habitats over time determine what long-term effects may occur. Contaminants degrade over time but may become sequestered as inert forms (e.g., buried in sediment) until disturbed and reactivated, producing renewed impacts.

If oil is ejected under high pressure or dispersants are applied at the source near the seafloor, oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor in some form, either concentrated (near the source) or dispersed and decayed (farther from the source). The oil could then impact patches of chemosynthetic community habitat in its path. The farther the dispersed oil travels, the more diluted it would become as it mixes with surrounding water. Chemosynthetic communities located at more than 610 m (2,000 ft) away from a blowout could experience minor impacts from suspended sediments that travel with currents, although the sediment concentration would be diluted with distance from the well. Studies indicate that periods of decades to hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type) (Powell, 1995; Fisher, 1995). There is evidence that substantial impacts on these communities could permanently prevent reestablishment, particularly if hard substrate required for recolonization is buried by resuspended sediments from a blowout. A catastrophic spill combined with the application of dispersant has the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect. Depending on how long it remains in the water column, oil may be thoroughly degraded by biological action before contacting the seafloor. Water currents can carry a plume to contact the seafloor directly but a more likely scenario would be for oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil would also reach the seafloor through planktonic consumption and associated excretion, which is distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). These mechanisms would result in a wide distribution of small amounts of oil (or oil by-products). This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Habitats directly under the path of the oil plume as it disperses and "rains" down to the seafloor may experience minor effects, but since the oil would be deposited in a widely scattered and decayed state, little effect is anticipated.

Overall Summary and Conclusion (Phases 1-4)

Chemosynthetic communities would potentially be subject to detrimental effects from a catastrophic seafloor blowout. Sediment and oiled sediment from the initial event (Phase 1) are not likely to reach chemosynthetic communities in heavy amounts because of requirements described in NTL 2009-G40. Fine sediment from a blowout may reach the location of sensitive habitats, producing sublethal effects. The initial accident could result in the drilling rig and equipment falling on a sensitive seafloor habitat if the structure travels more than 610 m (2,000 ft) from the well site.

The ongoing spill event (Phase 2) would have the most effect on chemosynthetic communities. Chemosynthetic communities are at risk from subsea oil plumes that could directly contact localized patches of sensitive habitat. Oil plumes reaching chemosynthetic communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. However, potential impacts would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. The more likely scenario would be exposure to widely dispersed, biodegraded particles that "rain" down from a passing oil plume. While a few patch habitats may be affected, the Gulfwide ecosystem of chemosynthetic communities would be expected to suffer no significant effects.

As oil approaches shore (Phase 3), there would be no additional adverse impacts to chemosynthetic communities because the chemosynthetic communities are located offshore in deep water (>300 m; 610 ft).

The recovery of chemosynthetic communities (Phase 4) depends on the severity of initial impacts. A catastrophic spill combined with the application of dispersant has the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. Studies indicate that periods from decades to hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type) (Powell, 1995; Fisher, 1995). The burial of hard substrate could permanently prevent recovery. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. However, most chemosynthetic community habitats are expected to experience no impacts from a catastrophic seafloor blowout because of the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution.

B.3.1.10. Nonchemosynthetic Deepwater Benthic Communities

Deepwater benthic communities of the Gulf of Mexico include soft bottom, chemosynthetic, and live bottom communities (mostly deepwater coral communities). Deep water, for ecology in the GOM, is defined as water depths over 300 m (984 ft) because nonchemosynthetic communities and *Lophelia* coral habitats have not been found in waters shallower than these depths. The possible impacts to nonchemosynthetic deepwater benthic communities from a catastrophic blowout depend on the location and the nature of the event.

Phase 1—Initial Event

During the initial phase of a catastrophic blowout, impacts may include disturbance of sediments, destruction of the drilling rig, release of oil and natural gas (methane), and emergency response efforts.

This phase deals with the immediate effects of a blowout located at least 3 nmi (3.5 mi; 5.6 km) from shore.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying many organisms within a few hundred meters of the wellhead. A blowout that occurs outside the well casing can rapidly deposit 30 cm (12 in) or more of sediment within a few hundred meters and may smother much of the soft bottom community in a localized area. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. Many of the organisms on soft bottoms live within the sediment and have the ability to migrate upward in response to burial by sedimentation. In situations where soft bottom infaunal communities are negatively impacted, recolonization by 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 1 year for most macrofauna and megafauna species. Recolonization could take longer for areas affected by direct contact of concentrated oil.

If a blowout were to occur close enough to a sensitive deepwater live bottom community, suspended sediment may impact the organisms. Restrictions described in NTL 2009-G40 require drilling to be removed at least 610 m (2,000 ft) from possible live bottom communities. During a blowout, suspended sediment may become contaminated with oil and subsequently deposit that oil down-current from the source. The highest concentrations of contamination would be nearest the well, and concentrations would diminish with distance. A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the sediment.

Destruction of the oil drilling rig and associated equipment could have an acute effect on any nonchemosynthetic communities caught under the direct impact of the equipment when it falls to the seafloor. However, the restrictions described in NTL 2009-G40 require drilling locations to be 610 m (2,000 ft) from any possible indications of sensitive live bottom communities, reducing the possibility that a rig would settle directly on sensitive habitat.

A catastrophic blowout would likely result in released oil rapidly rising to the sea surface because typical reserves in the GOM have specific gravity characteristics that are much lighter than water (refer to **Chapter 3.2.1.3** of this Supplemental EIS; Environment Canada, 2011; Trudel et al., 2001). The oil would surface almost directly over the source location. Oil floating to the sea surface would be effectively removed from affecting nonchemosynthetic communities on the seafloor. Even oil treated with chemical dispersants on the sea surface would not be expected to have widespread impacts to deepwater communities. Reports on dispersant usage on surface oil indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981; Lewis and Aurand, 1997). Lubchenco et al. (2010) report that chemically dispersed surface oil from the *Macondo* well blowout and oil spill remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. However, if the oil is ejected under high pressure, micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). Upward movement of the oil may also be reduced if methane mixed with the oil is dissolved into the water column, reducing the buoyancy of the oil/gas stream (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). It is unlikely that any deepwater live bottom community would be affected by the initial stage of a catastrophic event due to the required separation of drilling activities from sensitive habitats, because released oil would rapidly rise to a level above the habitat, and because surface oil would not mix to the depths of such communities. The required separation distance would also allow for a subsea plume to mix with the surrounding water and become diluted before it reached a deepwater community.

Phase 2—Offshore Spill

During the second phase of a catastrophic blowout, the major impact of concern is the release of oil and methane over time. Response efforts may produce additional impacts. This chapter deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

A spill resulting from a catastrophic blowout in deep water has the potential to impact offshore benthic communities; however, it is not likely that deepwater benthic communities would be affected by a spill from a shallow-water blowout. Although subsurface plumes can be generated when oil is ejected under high pressure or when dispersants are used subsea, a majority of the oil originating from a seafloor blowout in deep water is expected to rise rapidly to the sea surface. Oil and chemical spills that originate at the sea surface are not considered to be a potential source of measurable impacts on deepwater, live bottom communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink, and the risk of weathered components of a surface slick reaching the benthos in any measurable concentration would be very small. Surface oil also could not physically mix to depths of deepwater communities under natural conditions (Lange, 1985; McAuliffe et al., 1975; McAuliffe et al., 1981a; Tkalich and Chan, 2002).

Upward movement of the oil may also be reduced if methane mixed with the oil is dissolved into the water (Adcroft et al., 2010). A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. One deepwater coral site at a depth of 1,370 m (4,495 ft) has been reported as severely damaged following the *Macondo* well blowout and oil spill. The site is in Mississippi Canyon Block 294, 11 km (7 mi) southwest of the spill location. The site includes hard substrate supporting coral in an area approximately 10 x 12 m (33 x 39 ft) (White et al., 2012). The published results document damage to the coral community. Forty-three coral colonies were analyzed via close-up imagery: 86 percent exhibited signs of impact; 46 percent exhibited impact to at least 50 percent of the colony; and 23 percent of the colonies sustained impact to more than 90 percent of the colony (White et al., 2012). Many other associated invertebrates also exhibited signs of stress. This appears to be an exceptional case, since the numerous other communities investigated since the spill remained healthy (White et al., 2012). Some of the oil in the water column would become diluted over time, reducing transport to the seafloor (Vandermeulen, 1982). Concentrations of dispersed and dissolved oil in the *Macondo* well blowout and spill subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010; Lubchenco et al., 2010). In addition, microbial degradation of the oil occurs in the water, rendering the oil less toxic when it contacts the seafloor (Hazen et al., 2010). However, as evidenced by the report of White et al. (2012), subsea plumes can still retain toxic concentrations over a distance of at least 11 km (7 mi). Oil in a plume can adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil also would reach the seafloor through consumption by plankton, with excretion distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). These mechanisms would result in a wide distribution of small amounts of oil. Throughout these processes, oil would be biodegraded from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010).

A sustained spill may result in elevated exposure concentrations to live bottom features if a subsea oil plume contacts them directly. Dispersed oil is mixed with water, and its movement is then dictated by water currents and the physical, chemical, and biological degradation pathways. BOEM's policy (refer to NTL 2009-G39) prevents wells from being placed immediately adjacent to sensitive communities; however, in the event of a seafloor blowout, some oil could be carried to live bottom communities by subsea plumes. Impacts may include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment. Concentrated oil plumes reaching live bottom communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. The longer the oil remains suspended in the water column the more dispersed, less concentrated, and more degraded it would become. Depending on how long oil remained suspended in the water column, it may be thoroughly degraded by biological action before contacting the seafloor (Hazen et al., 2010; Valentine et al., 2010). Biodegradation rates in cold, deepwater environments are not well understood at this time. In general, the potential impacts to deepwater live bottom communities would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. While a few patch habitats may be affected, the Gulfwide ecosystem of deepwater live bottom communities would be expected to suffer no significant effects.

Drilling muds comprised primarily of barite may be pumped into a well to stop a blowout. If a "kill" is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on stipulations as described in NTL 2009-G40, a well should be far enough away from sensitive live bottom communities to prevent extruded drilling muds from smothering them.

Phase 3—Onshore Contact

The third phase of a catastrophic blowout focuses on the approach of oil to the shoreline. This involves the possible oiling of coastal resources including beaches, wetlands, SAV and seagrasses, the shallow seafloor, and any resources drifting in the water column. Response efforts can produce additional serious impacts. There would be no adverse impacts to nonchemosynthetic benthic communities in deep water as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill because the communities are located offshore in deep water (>300 m; 610 ft).

Phase 4—Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both the natural rate of recovery and the persistence of oil in natural habitats over time determine what long-term effects may occur. Contaminants degrade over time, but they may become sequestered as inert forms (e.g., buried in sediment) until disturbed and re-activated, producing renewed impacts.

Although deepwater coral and other live bottom communities often live in close association with hydrocarbon seeps (since the carbonate substrate is precipitated by chemosynthetic communities), this does not mean they are necessarily tolerant to the effects of oil contamination. Natural seepage is very constant and at very low rates as compared with the potential volume of oil released from a catastrophic event (blowout or pipeline rupture). In addition, live bottom organisms, such as *Lophelia pertusa*, inhabit areas around the perimeter of seeps and sites where hydrocarbon seepage has reduced its flow or stopped. Typical Gulf of Mexico oil is light and floats rapidly to the surface rather than being carried horizontally across benthic communities by water currents (Johansen et al., 2001; MacDonald et al., 1995; Trudel et al., 2001). So, although deepwater live bottom communities are found near oil seeps, they are not typically exposed to concentrated oil.

If oil is ejected under high pressure or dispersants are applied at the source near the seafloor, oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor in some form, either concentrated (near the source) or dispersed and decayed (farther from the source). The oil could then impact patches of live bottom community habitat in its path. The farther the dispersed oil travels, the more diluted it would become as it mixes with surrounding water. Sensitive live bottom communities located at more than 610 m (2,000 ft) away from a blowout could experience minor impacts from suspended sediments that travel with currents, although the sediment concentration would be diluted with distance from the well.

There have been no experiments showing the response of deepwater corals to oil exposure. Experiments with shallow tropical corals indicate that corals have a high tolerance to oil exposure. The mucus layers on coral resist penetration of oil and slough off the contaminant. Longer exposure times and areas of tissue where oil adheres to the coral are more likely to result in tissue damage and death of polyps. Corals with branching growth forms appear to be more susceptible to damage from oil exposure (Shigenaka, 2001). The most common deepwater coral, *Lophelia pertusa*, is a branching species. Tests with shallow tropical gorgonians indicate relatively low toxic effects to the coral (Cohen et al., 1977), suggesting deepwater gorgonians may have a similar response. Depending on the level of exposure, the response of deepwater coral to oil from a catastrophic spill would vary. Exposure to widely dispersed oil adhering to organic detritus and partially degraded by bacteria may be expected to result in little effect. Direct contact with plumes of relatively fresh dispersed oil droplets in the vicinity of the incident could cause the death of affected coral polyps through exposure and potential feeding on oil droplets by polyps. Median levels of exposure to dispersed oil in a partly degraded condition may result in effects similar to those of shallow tropical corals, with often no discernible effects other than temporary contraction and some sloughing. The health of corals may be degraded by the necessary expenditure of energy as the corals respond to oiling (Shigenaka, 2001). Communities exposed to more concentrated oil may experience detrimental effects, including death of affected organisms, tissue damage, lack of growth, interruption of reproductive cycles, and loss of gametes. Many invertebrates associated with deepwater coral communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure. The recolonization of severely damaged or destroyed communities could take years or decades. Burial of hard substrate could permanently prevent recovery. However, because of the scarcity of deepwater hard bottoms, their comparatively low surface area, and the distancing requirements set by BOEM in NTL 2009-G40, it is unlikely that a sensitive habitat would be located adjacent to a seafloor blowout or that concentrated oil would contact the site.

A catastrophic spill combined with the application of dispersant has the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect. Depending on how long it remains in the water column, oil may be thoroughly degraded by biological action before contacting the seafloor. Water currents can carry a plume to contact the seafloor directly, but a more likely scenario would be for oil to adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil also would reach the seafloor through consumption by plankton with excretion distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). These mechanisms would result in a wide distribution of small amounts of oil (or oil by-products). This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Habitats directly under the path of the oil plume as it disperses and "rains" down to the seafloor may experience minor effects, but since the oil would be deposited in a widely scattered and decayed state, little effect is anticipated.

Overall Summary and Conclusion (Phases 1-4)

Nonchemosynthetic communities would potentially be subject to detrimental effects from a catastrophic seafloor blowout. Sediment and oiled sediment from the initial event (Phase 1) are not likely to reach sensitive live bottom communities in heavy amounts because of requirements described in NTL 2009-G40. Fine sediment from a blowout may reach the location of sensitive habitats, producing sublethal effects. The initial accident could result in the drilling rig and equipment falling on a sensitive seafloor habitat if the structure travels more than 610 m (2,000 ft) from the well site.

The ongoing spill event (Phase 2) would have the most effect on nonchemosynthetic communities. Deepwater live bottom communities are at risk from subsea oil plumes that could directly contact localized patches of sensitive habitat. Oil plumes reaching live bottom communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. However, the potential impacts would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. The more likely result would be exposure to widely dispersed, biodegraded particles that "rain" down from a passing oil plume. While a few patch habitats may be affected, the gulf-wide ecosystem of live bottom communities would be expected to suffer no significant effects.

As oil approaches shore (Phase 3), there would be no adverse impacts to nonchemosynthetic communities because the communities are located offshore in deep water (>300 m; 610 ft).

The recovery of nonchemosynthetic communities (Phase 4) depends on the severity of initial impacts. A catastrophic spill combined with the application of dispersant has the potential to cause devastating effects on local patches of sensitive habitat in the path of subsea plumes where they physically contact the seafloor. The recolonization of severely damaged or destroyed communities could take years or decades. Burial of hard substrate could permanently prevent recovery. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. However, most live bottom community habitats are expected to experience no impacts from a catastrophic seafloor blowout because of the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution.

B.3.1.11. Soft Bottom Benthic Communities

The seafloor on the continental shelf in the Gulf of Mexico consists primarily of muddy to sandy sediments. Benthic organisms found on the seafloor 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, sponges, soft and hard corals, and demersal fishes). Infauna is comprised of meiofauna, small organisms (63-500 μm) that live among the grains of sediment; and macroinfauna, slightly larger organisms (>0.5 mm; 0.02 in) that live in the sediment (Dames and Moore, Inc., 1979). Shrimp and demersal fish are closely associated with the benthic community. The most abundant organisms on the continental shelf are the deposit-feeding polychaetes. The slope and deep sea consist of vast areas of primarily fine sediments that support benthic communities with lower densities and biomass but higher diversity than the continental shelf (Rowe and Kennicutt, 2001).

Phase 1—Initial Event

A blowout from an oil well could result in a catastrophic spill event. A catastrophic blowout would result in released oil rapidly rising to the sea surface because all known reserves in the GOM have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. The oil would surface almost directly over the source location. However, if the oil is ejected under high pressure, micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsea plumes or sinking oil on particulates may contact portions of the seafloor.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying many organisms within a few hundred meters of the wellhead. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. The localized seafloor habitat around which a seafloor blowout occurs would be impacted by suspended and redeposited sediment.

A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the sediment.

The use of subsea dispersants would increase the exposure of offshore benthic habitats to dispersed oil droplets in the water column, as well as the chemicals used in the dispersants. The use of subsea dispersants is not likely to occur for seafloor blowouts outside the well casing.

Impacts to Soft Bottom Benthic Communities

Impacts that occur to benthic organisms as a result of a blowout would depend on the type of blowout and their distance from the blowout. Also, if the blowout were to occur beneath the seabed, soft sediment habitat would be destroyed by the formation of a crater, and the suspension and subsequent deposition of disturbed sediment would smother localized areas of benthic communities. A blowout that occurs outside the well casing can rapidly deposit 30 cm (12 in) or more of sediment within a few hundred meters and may smother much of the soft bottom community in a localized area. Benthic communities exposed to large amounts of resuspended and deposited sediments following a catastrophic, subsurface blowout could be subject to smothering, sediment suffocation, and exposure to resuspended toxic contaminants. Impacts to organisms as a result of sedimentation would vary based on species tolerance, degree of sedimentation, length of exposure, burial depth, and vertical migration ability through sediment.

A portion or the entire rig may sink to the seafloor as a result of a blowout. The benthic features and communities upon which the rig settles would be destroyed or smothered. A settling rig may suspend sediments, which may smother nearby benthic communities. The habitats beneath the rig may be permanently lost; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration if the hard substrate upon which they live was not physically destroyed.

Phase 2—Offshore Spill

A spill from a shallow-water blowout could impact benthic communities on the continental shelf. The scenario (**Table B-4**) for a catastrophic spill on the continental shelf is assumed to last 2-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana midrange paraffinic sweet crude oil could be released, which would float (APIº >10). An anticipated 35,000 bbl of dispersant may be applied to the surface waters.

A spill from a deepwater blowout could also impact shelf communities and deepwater communities. The scenario (**Table B-4**) for a catastrophic spill in deep water is assumed to last 4-6 months and to release 30,000-60,000 bbl per day. A total volume of 2.7-7.2 MMbbl of South Louisiana midrange paraffinic sweet crude oil could be released, which would float (APIº >10). Oil properties may change as it passes up the well and through the water column, and it may become emulsified. An anticipated 33,000 bbl of dispersant may be applied to the surface waters and 16,500 bbl may be applied subsea. Weathering and dilution of the oil would also occur as it travels from its launch point. It is unlikely that a subsurface plume from a deepwater blowout would impact shelf communities. The oil is anticipated to remain in deep water and be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts to Soft Bottom Benthic Communities

Impacts from Surface Oil

Surface oil slicks can spread over a large area; however, the majority of the slick is comprised of a very thin surface layer of oil moved by winds and currents (Lewis and Aurand, 1997). The potential of surface oil slicks to affect benthic habitats is limited by its ability to mix into the water column. Soft bottom benthic communities below 10-m (33-ft) water depth are protected from surface oil because of its lack of ability to mix with water (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Benthic organisms would not become physically coated or smothered by surface oil. However, if this surface oil makes its way into the water column through physical mixing, the use of dispersants, or the sedimenting to particles in the water column, benthic communities may be impacted. These scenarios are discussed in later sections.

Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10-20 m (33-66 ft) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Therefore, soft bottom benthic communities located in shallow water have the potential to be fouled by oil that is floating on shallow water and mixes to the depth of the seafloor. Nearshore oil deposits that occur in sheltered areas, such as bays, may remain in the sediment and impact organisms for long periods. Oil in nearshore sediments was found in high concentrations 8 years following the *Exxon Valdez* spill (Dean and Jewett, 2001). Benthic communities located in deeper water would not be impacted by oil physically mixed into the water column. However, if dispersants are used, they would enable oil to mix into the water column and possibly impact organisms in deeper water. Dispersants are discussed later in this chapter. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Impacts from Subsurface Oil

The presence of a subsurface oil plume on the continental shelf from a shallow-water blowout may affect soft bottom benthic communities. A majority of the oil released is expected to rise rapidly to the sea surface above the launch point because of the specific gravity characteristics of the oil reserves in the GOM, thus not directly sinking to the seafloor and smothering benthic communities. If the oil is ejected under high pressure, oil droplets may become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsurface plumes generated by high-pressure dissolution of oil may come in contact with portions of the seafloor as it travels from the source. A sustained spill would continuously create surface slicks and possibly subsurface plumes. Some of the oil in the water column will become diluted or evaporated over time, reducing any localized transport to the seafloor (Vandermeulen, 1982). In addition, microbial degradation of the oil occurs in the water column so that the oil would be less toxic as it travels from the source (Hazen et al., 2010). However, a sustained spill may result in elevated exposure concentrations to benthic communities if the plume reaches them. The longer the spill takes to stop, the longer the exposure time and higher the exposure concentration may be.

Soft bottom infaunal communities that come into direct contact with oil may experience sublethal and/or lethal effects. The greatest effects of oil exposure would occur close to the well and impacts would decrease with distance. A subsurface plume that contacts the seafloor may result in acute toxicity. The water accommodated fraction (WAF) or water soluble fraction (WSF) of oil that dissolves in water may be the most toxic to organisms, especially larvae and embryos in the water column or at the water sediment interface. Lethal effects for marine invertebrates have been reported at exposures between 0.10 ppm to 100 ppm WSF of oil (Suchanek, 1993). The WSF of petroleum hydrocarbons was reportedly highly toxic to the embryos of oysters and sea urchins, while sediment containing weathered fuel was not toxic to the same species (Beiras and Saco-Álvarez, 2006). Quahog clam embryos and larvae also experienced toxicity and deformation of several different crude oils at WSF concentrations between 0.10 ppm and 10 ppm (Byrne and Calder, 1977). An experiment indicated that the WSF of No. 2 fuel oil at a concentration of 5 ppm disrupted the cellular development of 270 out of 300 test organisms within 3 hours of exposure (Byrne, 1989). After 48 hours exposure, all of the test organisms died and the 48-hour LC_{50} (lethal concentration for 50% of the test population) was calculated to be 0.59 ppm (Byrne, 1989). Another experiment indicated that a WSF of 0.6 ppm and greater of No. 2 fuel oil depressed respiration, reduced mobility of sperm, interfered with cell fertilization and embryonic cleavage, and retarded larval development of sand dollar eggs (Nicol et al., 1977). Experiments that exposed sea urchin embryos to 10-30 ppm WSF of diesel oil for 15-45 days resulted in defective embryonic development and nonviable offspring (Vashchenko, 1980). Therefore, any dissolved petroleum hydrocarbon constituents that reach larval benthic organisms may cause acute toxicity and other developmental effects to this life stage. The WAF and WSF, however, should be considered "worst-case scenario" values as they are based on a closed system at equilibrium with the contaminant and, due to its size and complexity, the GOM will not reach equilibrium with released oil.

Oil in the water column may impact pelagic eggs and larvae of invertebrates. Toxicity tests indicated that eggs of many species were killed by diesel oil in seawater, and in general, the smaller eggs died earlier (Chia, 1973). Bivalve fertilization and sperm fertility were depressed with exposure to crude oil (Renzoni, 1975). The WSF of crude oil was also highly toxic to gametes, embryos, and larvae of bivalves (Renzoni, 1975). Oil concentrations of 0.1 and 1 ppm caused a decrease in fertilization, development of embryos, survival or larvae, and larval growth in the bivalves *Crassostrea virginica* and *Mulinia lateralis* (Renzoni, 1975). Another experiment, however, calculated the LC_{50} for a 6-hour exposure of the gametes, eggs, and larvae of three bivalves (*Crassostrea angulata*, *Crassostrea gigas*, and *Mytilus galloprovincialis*) to be 1,000 ppm oil and 1,000 ppm oil plus dispersant (Renzoni, 1973). Toxicity varies widely among species and oil types.

Sublethal responses of marine invertebrates may result in population level changes (Suchanek, 1993). Such sublethal responses may occur at concentrations as low as 1-10 ppb (Hyland and Schneider, 1976). Sublethal impacts may include reduced feeding rates, reduced ability to detect food, ciliary inhibition, reduced movement, decreased aggression, and altered respiration (Suchanek, 1993).

The farther a subsea plume travels, the more physical and biological changes occur to the oil before it reaches benthic organisms. Oil would become diluted as it physically mixes with the surrounding water, and significant evaporation occurs from surface slicks. The most toxic compounds of oil are lost within the first 24 hours of a spill, leaving the heavier, less toxic compounds in the system (Ganning et al., 1984). An even greater component of the lighter fuel oils dissipates through evaporation. Water currents could carry a plume to contact the seafloor directly, but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (International Tanker Owners Pollution Federation Limited, 2002; Kingston et al., 1995). Oil also would reach the seafloor through consumption by plankton, with excretion distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2002). The longer and farther a subsea plume travels in the sea, the more dilute the oil would be (Vandermeulen, 1982; Tkalich and Chan, 2002). In addition, microbial degradation of the oil occurs in the water column, reducing toxicity (Hazen et al., 2010; McAuliffe et al., 1981b). The oil would move in the direction of prevailing currents (S.L. Ross Environmental Research Ltd., 1997) and, although the oil would weather with the distance it travels, low levels of oil transported in subsea plumes would impact benthic communities. These mechanisms would result in a wide distribution of small amounts of oil. This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010).

Localized areas of lethal effects would be recolonized by populations from neighboring soft bottom substrate once the oil in the sediment has been sufficiently reduced to a level able to support marine life (Sanders et al., 1980; Lu and Wu, 2006; Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000; Dean and Jewett, 2001). This initial recolonization process may be fairly rapid, but full recovery may take up to 10 years depending on the species present, substrate in the area, toxicity of oil spilled, concentration and dispersion of oil spilled, and other localized environmental factors that may affect recruitment (Kingston et al., 1995; Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). Opportunistic species would take advantage of the barren sediment, repopulating impacted areas first. These species may occur within the first recruitment cycle of the surrounding populations or from species immigration from surrounding stocks and may maintain a stronghold in the area until community succession begins (Rhodes and Germano, 1982; Sanders et al., 1980).

It is unlikely that a subsurface plume from a deepwater blowout would impact shelf communities. The oil is anticipated to remain in deep water and be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008). However, the impacts to deepwater soft bottom benthic communities as a result of a blowout would similar to those on the continental shelf.

Impacts from Dispersed Oil

If dispersants are used at the sea surface, oil may mix into the water column, and if they are applied subsea, dispersed oil can travel with currents and contact the seafloor. Chemically dispersed oil from a surface slick is not anticipated to result in lethal exposures to organisms on the seafloor. The chemical dispersion of oil may increase the weathering process and allow surface oil to be diluted by greater amounts of water. Reports on dispersant usage on surface plumes indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (6 ft) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing oiled sediments from traveling to the seafloor (McAuliffe et al., 1981a). If applied, subsea benthic communities near the source could be exposed to dispersed oil that is concentrated enough to harm the benthic community. If the oil remains suspended for a longer period of time, it would be more dispersed and less concentrated. There is very little information on the behavior of subsea dispersants.

Dispersed oil used at the sea surface reaching the benthic communities in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a). Such concentrations would not be life threatening to larval or adult stages on the seafloor based on experiments conducted with benthic and pelagic species (Scarlett et al., 2005; Hemmer et al., 2010; George-Ares and Clark, 2000). Any dispersed oil in the water column that comes in contact with benthic communities may evoke short-term negative responses by the organisms (Scarlett et al., 2005). Sublethal responses may include reduced feeding rate, erratic movement, and tentacle retraction (Scarlett et al., 2005). In addition, although dispersants were detected in waters off Louisiana after the *Macondo* well blowout and spill, they were below USEPA benchmarks of chronic toxicity (OSAT, 2010). The rapid dilution of dispersants in the water column and lack of transport to the seafloor was also reported by OSAT (2010) where no dispersants were detected in sediment on the Gulf floor following the *Macondo* well blowout and spill.

Impacts from Oil Adhering to Sediments

Oiled sediment that settles to the seafloor may affect organisms upon which it settles. The greatest impacts would be closest to the well where organisms may become smothered by particles and exposed to hydrocarbons. High concentrations of suspended sediment in the water column may lend to large quantities of oiled sediment (Moore, 1976). Deposition of oiled sediment is anticipated to begin occurring within days or weeks of the spill and may be fairly deep near the source (Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000). Oily sand layers were reported to be 10 cm (4 in) deep on the seafloor near the *Amoco Cadiz* spill (Gómez Gesteira and Dauvin, 2000). Acute toxicity may occur near the spill, eliminating benthic communities.

Much of the oil released from a blowout would rise to the sea surface, therefore dispersing the released oil before it makes its way back to the seafloor through flocculation, by deposition from organisms that pass it through their systems with food, and by adhering to sinking particles in the water column. In addition, small droplets of oil that are entrained in the water column for extended periods of time may migrate a great distance from their point of release and may attach to suspended particles in the water column and later be deposited on the seafloor (McAuliffe et al., 1975). The majority of organisms exposed to oiled sediment are anticipated to experience low-level concentrations because as the oiled sediments settle to the seafloor they are widely dispersed. Impacts may include reduced recruitment success, reduced growth, and altered community composition as a result of impaired recruitment.

Impacts from Oil-Spill-Response Activity

Continued localized disturbance of soft bottom communities may occur during oil-spill response efforts. Anchors used to set booms to contain oil or vessel anchors in decontamination zones may affect infaunal communities in the response activity zone. Infaunal communities may be altered in the anchor scar, and deposition of suspended sediment may result from the setting and resetting of anchors. The disturbed benthic community should begin to repopulate from the surrounding communities during their next recruitment event and through immigration of organisms from surrounding stocks. Any decontamination activities, such as cleaning vessel hulls of oil, may also contaminate the sediments of the decontamination zone, as some oil may settle to the seabed, impacting the underlying benthic community.

If a blowout occurs at the seafloor, drilling muds (primarily barite) may be pumped into a well in order to “kill” it. If a kill is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath heavy layers of the extruded drilling mud would be buried. Base fluids of drilling muds are designed to be low in toxicity and biodegradable in offshore marine sediments (Neff et al., 2000). However, as bacteria and fungi break down the drilling fluids, the sediments may temporarily become anoxic (Neff et al., 2000). Benthic macrofaunal recovery would occur when drilling mud concentrations are reduced to levels that enable the sediment to become re-oxygenated (Neff et al., 2000). Complete community recovery from drilling mud exposure may take 3-5 years, although microbial degradation of drilling fluids, followed by an influx of tolerant opportunistic species, is anticipated to begin almost immediately (Neff et al., 2000). In addition, the extruded mud may bury hydrocarbons from the well, making them a hazard to the infaunal species and difficult to remove.

Phase 3—Onshore Contact

There would likely be no additional adverse impacts to soft bottom benthic communities as a result of events and the potential impact producing factors that could occur throughout Phase 3 of a catastrophic spill because these soft bottom benthic communities are located below the water line.

Phase 4—Post-Spill, Long-Term Recovery and Response

Benthic Habitats

In situations where soft bottom infaunal communities are negatively impacted, recolonization by populations from neighboring soft bottom substrate would be expected over a relatively short period. Recolonization would begin with recruitment and immigration of opportunistic species from surrounding stocks. More complex communities would follow with time. Repopulation could take longer for areas affected by direct oil contact in higher concentrations.

Many of the organisms on soft bottoms live within the sediment and have the ability to migrate upward in response to burial by sedimentation. A blowout that occurs outside the well casing can rapidly deposit 30 cm (12 in) or more of sediment within a few hundred meters and may smother much of the soft bottom community in a localized area. In situations where soft bottom infaunal communities are negatively impacted, recolonization by 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 1 year for most macrofauna and megafauna species. Recolonization could take longer for areas affected by direct contact of concentrated oil. Initial repopulation from nearby stocks of pioneering species, such as tube-dwelling polychaetes or oligochaetes, may begin with the next recruitment event (Rhodes and Germano, 1982). Full recovery would follow as later stages of successional communities overtake the pioneering species (Rhodes and Germano, 1982). The time it takes to reach a climax community may vary depending on the species and degree of impact. Full benthic community recovery may take years to decades if the benthic habitat is heavily oiled (Gómez Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). A slow recovery rate would result in a community with reduced biological diversity and possibly a lesser food value for predatory species.

Localized areas of lethal effects would be recolonized by populations from neighboring soft bottom substrate once the oil in the sediment has been sufficiently reduced to a level able to support marine life (Sanders et al., 1980; Lu and Wu, 2006; Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000; Dean and Jewett, 2001). This initial recolonization process may be fairly rapid, but full recovery may take up to 10 years depending on the species present, substrate in the area, toxicity of oil spilled, concentration and dispersion of oil spilled, and other localized environmental factors that may affect recruitment (Kingston et al., 1995; Gómez Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). Opportunistic species would take advantage of the barren sediment, repopulating impacted areas first. These species may occur within the first recruitment cycle of the surrounding populations or from species immigration from surrounding stocks and may maintain a stronghold in the area until community succession begins (Rhodes and Germano, 1982; Sanders et al., 1980).

Overall Summary and Conclusion (Phases 1-4)

A catastrophic blowout and spill would have the greatest impact on the soft bottom benthic communities in the immediate vicinity of the spill. Turbidity, sedimentation, and oiling would be heaviest closest to the source, and decrease with distance from the source. Complete loss of benthic populations may occur with heavy sedimentation and oil deposition. Farther from the well, a less thick layer of sediment would be deposited and oil would be dispersed from the source, resulting in sublethal impacts. The recovery of benthic populations would begin with recruitment from surrounding areas fairly rapidly.

B.3.1.12. Marine Mammals

Phase 1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout event. Impacts, response, and intervention depend on the spatial location of the blowout and leak. For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, this could result in a fire that would burn for 1 or 2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month. The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. Regardless of water depth, the immediate response would be from search and rescue vessels and aircraft, such as USCG cutters, helicopters, and rescue planes, and firefighting vessels. Potential impacts reflect the explosion, subsequent fire for 1-30 days, and the sinking of the platform in the immediate vicinity and up to 1 mi (1.6 km) from the well.

Depending on the type of blowout, the pressure waves and noise generated by the eruption of gases and fluids would likely be significant enough to harass, injure, or kill marine mammals, depending on the proximity of the animal to the blowout. A high concentration of response vessels could result in harassment or displacement of individuals and could place marine mammals at a greater risk of vessel collisions, which would likely cause fatal injuries.

The scenarios for each phase, including cleanup methods, can be found in **Table B-4**.

Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters. A catastrophic spill would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Potential impacts reflect spill and response in Federal and State offshore waters. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

An oil spill and related spill-response activities can impact marine mammals that come into contact with oil and remediation efforts. The marine mammals' exposure to hydrocarbons persisting in the sea may result in sublethal impacts (e.g., decreased health, reproductive fitness, longevity, and increased vulnerability to disease), some soft tissue irritation, 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. More detail on the potential range of effects to marine mammals from contact with spilled oil can be found in Geraci and St. Aubin (1990). The best available information does not provide a complete understanding of the effects of the spilled oil and active response/cleanup activities on marine mammals. For example, it is expected that the large amount of chemical dispersants being used on the oil may act as an irritant on the marine mammals' tissues and sensitive membranes.

The increased human presence after an oil spill (e.g., vessels) would likely add to changes in behavior and/or distribution, thereby potentially stressing marine mammals further and perhaps making them more vulnerable to various physiologic and toxic effects. In addition, the large number of response vessels could place marine mammals at a greater risk of vessel collisions, which could cause fatal injuries.

The potential biological removal (PBR) level is defined by the Marine Mammal Protection Act as the maximum number of animals, not including natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. However, in the Gulf of Mexico, many marine mammal species have unknown PBR's or PBR's with outdated abundance estimates, which are considered undetermined. The biological significance of any injury or mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and size of the marine mammals affected.

The *Deepwater Horizon* explosion, oil spill, and response in Mississippi Canyon Block 252 (including use of dispersants) have impacted marine mammals that have come into contact with oil and remediation efforts. According to the "Dolphins and Whales of the Gulf of Mexico Oil Spill" website, within the designated *Deepwater Horizon* explosion, oil spill, and response area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 Kogia spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NMFS, 2011b). All marine mammals collected either alive or dead were found east of the Louisiana/Texas border through Apalachicola, Florida. The highest concentration of strandings has occurred off eastern Louisiana, Mississippi, and Alabama, with a significantly lesser number off western Louisiana and western Florida (USDOC, NMFS, 2011b). Due to known low-detection rates of carcasses, it is possible that the number of deaths of marine mammals is underestimated (Williams et al., 2011). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses collected were related to the *Deepwater Horizon* explosion, oil spill, and response. These stranding numbers are significantly greater than reported in past years; though it should be further noted that stranding coverage (i.e., effort in collecting strategies) has increased considerably due to the *Deepwater Horizon* explosion, oil spill, and response. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response and oil initially reaching the shoreline during the spill event or while the oil still persists in the offshore environment once the spillage has been stopped. It is likely that Phases 2 and 3 could occur simultaneously. The duration of the initial shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. Re-oiling of already cleaned or previously impacted areas could be expected during Phase 3. In addition to the response described in Phase 2, nearshore and onshore efforts would be introduced in Phase 3 as oil entered coastal areas and contacted shore. Potential impacts reflect the spill and response in very shallow coastal waters and once along the shoreline. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

A high-volume oil spill lasting 90 days could directly impact over 22 species of marine mammals. As a spill enters coastal waters, manatees and coastal and estuarine dolphins would be the most likely to be affected.

Manatees primarily inhabit open coastal (shallow nearshore) areas and estuaries, and they are also found far up in freshwater tributaries. Florida manatees have been divided into four distinct regional management units: the Atlantic Coast Unit that occupies the east coast of Florida, including the Florida Keys and the lower St. Johns River north of Palatka, Florida; the Southwest Unit that occurs from Pasco County, Florida, south to Whitewater Bay in Monroe County, Florida; the Upper St. Johns River Unit that occurs in the river south of Palatka, Florida; and the Northwest Unit that occupies the Florida Panhandle south to Hernando County, Florida (Waring et al., 2012). Manatees from the Northwest Unit are more likely to be seen in the northern GOM, and they can be found as far west as Texas; however, most sightings are in the eastern GOM (Fertl et al., 2005).

During warmer months (June to September), manatees are common along the Gulf Coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida. Although manatees are less common farther westward, manatee sightings increase during the warmer summer months. Winter habitat use is primarily influenced by water temperature as animals congregate at natural (springs) and/or artificial (power plant outflows) warm water sources (Alves-Stanley et al., 2010). Manatees are infrequently found as far west as Texas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro et al., 1998). If a catastrophic oil spill reached the Florida coast when manatees were in or near coastal waters, the spill could have population-level effects.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the spill site could affect them. A manatee present where there is vessel traffic could be injured or killed by a vessel strike (Wright et al., 1995). Due to the large number of vessels responding to a catastrophic spill both in coastal waters and traveling through coastal waters to the offshore site, manatees would have an increased risk of collisions with boats. Vessel strikes are the primary cause of death of manatees.

The best available count of Florida manatees is 4,834 animals, based on a January 2011 aerial survey of warm water refuges (Florida Fish and Wildlife Conservation Commission, 2011). By November 2012, there were 306 manatee carcasses collected in Florida, 80 of these animals died of human causes (Florida Fish and Wildlife Conservation Commission, 2012). Human causes included water control structures, entanglement in and ingestion of marine debris, entrapment in pipes/culverts, and collisions with watercraft. Eight-six percent of the manatees that died of human causes were killed by watercraft (Florida Fish and Wildlife Conservation Commission, 2012). Therefore, if a catastrophic spill and response vessel traffic occurred near manatee habitats in the eastern Gulf of Mexico, population-level impacts could occur because the possibility exists for the number of mortalities to exceed the potential biological removal.

There have been no experimental studies and only a few observations suggesting that oil impacts have harmed any manatees (St. Aubin and Lounsbury, 1990). Types of impacts to manatees and dugongs from contact with oil include (1) asphyxiation because of inhalation of hydrocarbons, (2) acute poisoning because of contact with fresh oil, (3) lowering of tolerance to other stress because of 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 because of oil sticking to the sensory hairs around their mouths (Preen, 1989, in Sadiq and McCain, 1993; Australian Maritime Safety Authority, 2003). 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.

Bottlenose dolphins were the most affected species of marine mammals from the *Deepwater Horizon* explosion, oil spill, and response. According to the "Dolphins and Whales of the Gulf of Mexico Oil Spill" website, within the designated *Deepwater Horizon* explosion, oil spill, and response area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 Kogia spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NMFS, 2011b). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses collected were related to the *Deepwater*

Horizon explosion, oil spill, and response. Bottlenose dolphins can be found throughout coastal waters in the Gulf of Mexico. Like manatees, dolphins could be affected, possibly to population level, by a catastrophic oil spill if it reaches the coast (as well as affecting them in the open ocean), through direct contact, inhalation, ingestion, and stress, as well as through collisions with cleanup vessels.

Phase 4—Post-Spill, Long-Term Recovery and Response

Phase 4 focuses on long term recovery once the well has been capped and the spill has stopped. During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and cleanup activities are concluding. While it is assumed that the majority of spilled oil would be dissipated offshore within 1-2 months (depending on season and temperature) of stopping the flow, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill. On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms. Potential impacts reflect long-term persistence of oil in the environment and residual and long term clean-up efforts.

Even after the spill is stopped, oilings or deaths of marine mammals would still likely occur because of oil and dispersants persisting in the water, past marine mammal/oil or dispersant interactions, and ingestion of contaminated prey. The animals' exposure to hydrocarbons persisting in the sea may result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) and some soft tissue irritation, 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. A catastrophic oil spill could lead to increased mortalities, resulting in potential population-level effects for some species/populations (USDOC, NMFS, 2010b).

On December 13, 2010, NMFS declared an unusual mortality event (UME) for cetaceans (whales and dolphins) in the Gulf of Mexico. An UME is defined under the Marine Mammal Protect Act as a "stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response." Evidence of the UME was first noted by NMFS as early as February 1, 2010, before the *Macondo* well blowout and spill. As of July 29, 2012, a total of 759 cetaceans (5% stranded alive and 95% stranded dead) have stranded since the start of the UME, with a vast majority of these strandings between Franklin County, Florida, and the Louisiana/Texas border. The 759 cetaceans include 6 dolphins killed during a fish-related scientific study and 1 dolphin killed incidental to trawl relocation for a dredging project. More detail on the UME can be found on NMFS's website (USDOC, NMFS, 2012a). In addition to investigating all other potential causes, scientists are investigating what role *Brucella* may have played in the UME, and this continues today.

On May 9, 2012, NOAA declared an UME for bottlenose dolphins in five Texas counties. The UME lasted from November 2011-March 2012, when 123 bottlenose dolphins stranded in Aransas, Calhoun, Kleberg, Galveston, and Brazoria Counties in Texas. The investigation is ongoing (USDOC, NMFS, 2012b).

Overall Summary and Conclusion (Phases 1-4)

Accidental events related to a CPA proposed action have the potential to have adverse, but not significant impacts to marine mammal populations in the GOM. Accidental blowouts, oil spills, and spill-response activities may 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.

B.3.1.13. Sea Turtles

Phase 1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout incident. Impacts, response, and intervention depend on the spatial location of the blowout and leak. For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, this could result in a fire that would burn for 1-2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month. The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. Regardless of water depth, the immediate response would be from search and rescue vessels and aircraft, such as USCG cutters, helicopters, and rescue planes, and firefighting vessels. Potential impacts reflect the explosion, subsequent fire for 1-30 days, and the sinking of the platform in the immediate vicinity and up to 1 mi (1.6 km) from the well.

Five species of sea turtles are found in the waters of the Gulf of Mexico: green, leatherback, hawksbill, Kemp's ridley, and loggerhead. All species are protected under the Endangered Species Act (ESA), and all are listed as endangered except the loggerhead turtle, which is listed as threatened. Depending on the type of blowout, an 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. A high concentration of response vessels could place sea turtles at a greater risk of fatal injuries from vessel collisions. 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.

Further, mitigation by burning puts turtles at risk because they tend to be gathered up in the corralling process necessary to concentrate the oil in preparation for the burning. Trained observers should be required during any mitigation efforts that include burning. The scenarios for each phase, including cleanup methods, can be found in **Table B-4**.

Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters. A catastrophic spill would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Potential impacts reflect spill and response in Federal and State offshore waters. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

Sea turtles are more likely to be affected by a catastrophic spill in shallow water than in deep water because not all sea turtles occupy a deepwater habitat. For example, Kemp's ridley sea turtles are unlikely to be in water depths of 160 ft (49 m) or greater. Hawksbill sea turtles are commonly associated with coral reefs, ledges, caves, rocky outcrops, and high energy shoals. Green sea turtles are commonly found in coastal benthic feeding grounds, although they may also be found in the convergence zones of the open ocean. Convergence zones are areas that also may collect oil. Leatherback sea turtles are commonly pelagic and are the sea turtle species most likely to be affected by a deepwater oil spill. As the spilled oil moves toward land, additional species of sea turtles are more likely to be affected.

The *Deepwater Horizon* explosion, oil spill, and response in Mississippi Canyon Block (including use of dispersants) have impacted sea turtles that have come into contact with oil and remediation efforts. For the latest available information on oiled or affected sea turtles documented in the area, refer to NMFS's "Sea Turtles and the Gulf of Mexico Oil Spill" website (USDOC, NMFS, 2011c).

According to this NMFS website, 1,146 sea turtles have been collected (537 alive, 609 deceased) as of February 15, 2011). Of these, 201 were greens, 16 Hawksbills, 809 Kemp's ridleys, 88 loggerheads, and the remaining 32 unknown (USDOC, NMFS, 2011c). Individuals were documented either through strandings or directed offshore captures. Due to low detection rates of carcasses in prior events, it is possible that the number of deaths of sea turtles is underestimated (Epperly et al., 1996). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that not all carcasses were related to the *Deepwater Horizon* explosion, oil spill, and response. Over the last 2 years, NOAA has documented increased numbers of sea turtle strandings in the northern GOM. Many of the stranded turtles were reported from Mississippi and Alabama waters, and very few showed signs of external oiling (believed to be related to the *Deepwater Horizon* explosion, oil spill, and response). Necropsy results from many of the stranded turtles indicate mortality due to forced submergence, which is commonly associated with fishery interactions. In May 2012, NMFS published the Draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (*Federal Register*, 2012). Further detail on this catastrophic OSRA run is contained in **Appendix C**.

The *Ixtoc I* well blowout and spill in the Bay of Campeche, Mexico, on June 3, 1979, resulted in the release of 500,000 metric tons (140 million gallons) of oil and the transport of this oil into the Gulf of Mexico (ERCO, 1982). Three million gallons of oil impacted Texas beaches (ERCO, 1982). According to the ERCO study, "Whether or not hypoxic conditions could, in fact, be responsible for areawide reductions in [invertebrate] faunal abundance is unclear, however." Of the three sea turtles found dead in the U.S., all had petroleum hydrocarbons in the tissues examined, and there was selective elimination of portions of this oil, indicating chronic exposure (Hall et al., 1983). Therefore, the effects of the *Ixtoc I* well blowout and spill on sea turtles in waters off Texas are still unknown.

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response, and on oil initially reaching the shoreline during the spill event or while the oil still persists in the offshore environment once the spillage has been stopped. It is likely that Phases 2 and 3 could occur simultaneously. The duration of the initial shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. The re-oiling of already cleaned or previously impacted areas could be expected during Phase 3. In addition to the response described in Phase 2, nearshore and onshore efforts would be introduced in Phase 3 as oil entered coastal areas and contacted shore. Potential impacts reflect the spill and response in very shallow coastal waters and once along the shoreline. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

Out of the five species of sea turtle that occur in the Gulf of Mexico, only four nest in the GOM. The largest nesting location for the Kemp's ridley sea turtle is in Rancho Nuevo, Mexico, but they also nest in Texas and Alabama. Loggerhead sea turtles nest in all states around the Gulf of Mexico. Green sea turtles have been cited nesting in Texas, Alabama, and Florida. Leatherback sea turtles mostly nest on the east coast of Florida but are recorded in Texas. Kemp's ridley, loggerhead, and green sea turtles are therefore most likely to be affected by a catastrophic oil spill when there is onshore and/or offshore contact.

Female sea turtles seasonally emerge during the warmer summer months to nest on beaches. Thousands of sea turtles nest along the Gulf Coast, and turtles could build nests on oiled beaches. Nests could also be disturbed or destroyed by cleanup efforts. Untended booms could wash ashore and become a barrier to sea turtle adults and hatchlings (USDOC, NOAA, 2010d). Hatchlings, with a naturally high mortality rate, could traverse the beach through oiled sand and swim through oiled water to reach preferred habitats of *Sargassum* floats. Response efforts could include mass movement of eggs from hundreds of nests or thousands of hatchlings from Gulf Coast beaches to the east coast of Florida or to the open ocean to prevent hatchlings entering oiled waters (Jernelöv and Lindén, 1981; USDOI, FWS, 2010b). Due to poorly understood mechanisms that guide female sea turtles back to the beaches where they hatched, it is uncertain if relocated hatchlings would eventually return to the Gulf Coast to nest (Florida Fish and Wildlife Conservation Commission, 2010). Therefore, shoreline oiling and response efforts may affect future population levels and reproduction (USDOI, NPS, 2010). Sea turtle hatchling exposure to, fouling by, or consumption of tarballs persisting in the sea following the dispersal of an oil slick would likely be fatal.

As a preventative measure during the *Deepwater Horizon* explosion, oil spill, and response, NMFS and FWS translocated a number of sea turtle nests and eggs that were located on beaches affected or potentially affected by spilled oil. According to the latest information on the NMFS stranding network website (USDOC, NMFS, 2011c), a total of 274 nests were translocated from GOM beaches to the east coast of Florida. These nests were mainly for hatchlings that would enter waters off Alabama and Florida's northwest Gulf Coast. Of these, 4 were from green turtles, 5 from Kemp's ridley, and 265 were loggerheads. The translocation effort ended August 19, 2010, at the time when biologists determined that risks to hatchlings emerging from beaches and entering waters off Alabama and Florida's northwest Gulf Coast had diminished significantly and that the risks of translocating nests during late incubation to the east coast of Florida outweighed the risks of letting hatchlings emerge into the Gulf of Mexico. The hatchlings resulting from the translocations were all released as of September 9, 2010.

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 strategy for cleanup operations should vary, depending on the season.

Phase 4—Post-Spill, Long-Term Recovery and Response

Phase 4 focuses on long-term recovery once the well has been capped and the spill has stopped. During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and that cleanup activities are concluding. While it is assumed that the majority of spilled oil would be dissipated offshore within 1-2 months (depending on season and temperature) of stopping the flow, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill. On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms. Potential impacts reflect long-term persistence of oil in the environment and residual and long-term cleanup efforts.

Sea turtles take many years to reach sexual maturity. Green sea turtles reach maturity between 20 and 50 years of age; loggerheads may be 35 years old before they are able to reproduce; and hawksbill sea turtles typically reach lengths of 27 in (69 cm) for males and 31 in (79 cm) for females before they can reproduce (USDOC, NMFS, 2010b). Declines in the food supply for sea turtles, which include invertebrates and sponge populations, could also affect sea turtle populations. While all of the pathways that an oil spill or the use of dispersants can affect sea turtles is poorly understood, some pathways may include the following: (1) oil or dispersants on the sea turtle's skin and body can cause skin irritation, chemical burns, and infections; (2) inhalation of volatile petroleum compounds or dispersants can damage the respiratory tract and lead to diseases; (3) ingesting oil or dispersants may cause injury to the gastrointestinal tract; and (4) chemicals that are inhaled or ingested may damage internal organs. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick would result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity and increased vulnerability to disease) to sea turtles. Other possible internal impacts might include harm to the liver, kidney, and brain function, as well as causing anemia and immune suppression, or they could lead to reproductive failure or death. The deaths of subadult and adult sea turtles may also drastically reduce the population.

Since January 1, 2011, a notable increase in sea turtle strandings has occurred in the northern GOM, primarily in Mississippi. While turtle strandings in this region typically increase in the spring, the recent increase is a cause for concern. The Sea Turtle Stranding and Salvage Network is monitoring and investigating this increase. The network encompasses the coastal areas of the 18 states from Maine through Texas and includes portions of the U.S. Caribbean. There are many possible reasons for the increase in strandings in the northern GOM, both natural and human caused (USDOC, NMFS, 2012c). One sea turtle had a small amount of tar from the *Deepwater Horizon* explosion, oil spill, and response on its shell. No visible external or internal oil was observed in any other animals. These sea turtle species include loggerhead, green, Kemp's ridley, leatherback, hawksbill, and unidentified. As of July 29, 2012, NMFS has identified 81 strandings in Texas (upper Texas coast – Zone 18).

Over the last 2 years, NOAA has documented necropsy results from many of the stranded turtles, indicating mortality due to forced submergence, which is commonly associated with fishery interactions, and acute toxicosis. On May 10, 2012, NMFS published the Draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (77 FR 27411) (*Federal Register*, 2012).

Overall Summary and Conclusion (Phases 1-4)

Accidental blowouts, oil spills, and spill-response activities resulting from a CPA 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. Impacts on sea turtles from smaller accidental events are likely to affect individual sea turtles in the spill area, but they are unlikely to rise to the level of population effects (or significance) given the size and scope of such spills.

Unavailable information on the effects to sea turtles from the *Deepwater Horizon* explosion, oil spill, and response and increased stranding events (and thus changes to the sea turtle baseline in the affected environment) makes an understanding of the effects less clear.

For low-probability catastrophic spills, this analysis concludes that there is a potential for a low-probability catastrophic event to result in significant, population-level effects on affected sea turtle species.

B.3.1.14. Diamondback Terrapins

Phase1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout event. Impacts, response, and intervention depend on the spatial location of the blowout and leak. For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, this could result in a fire that would burn for 1-2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month. The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. Regardless of water depth, the immediate response would be from search and rescue vessels and aircraft, such as USCG cutters, helicopters, and rescue planes, and firefighting vessels. Potential impacts reflect the explosion, subsequent fire for 1-30 days and the sinking of the platform in the immediate vicinity and up to 1 mi (1.6 km) from the well.

The scenarios for each phase, including cleanup methods, can be found in **Table B-4**.

There would likely be no adverse impacts to diamondback terrapins as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because these species exclusively inhabit estuarine waters and salt marshes.

Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters. A catastrophic spill would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Potential impacts reflect spill and response in Federal and State offshore waters. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

There would likely be no adverse impacts to diamondback terrapins as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because these species exclusively inhabit estuarine waters and salt marshes.

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response and on oil initially reaching the shoreline during the spill event or while the oil still persists in the offshore environment once the spillage has been stopped. It is likely that Phases 2 and 3 could occur simultaneously. The duration of the initial shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. The re-oiling of already cleaned or previously impacted areas could be expected during Phase 3. In addition to the response described in Phase 2, nearshore and onshore efforts would be introduced in Phase 3 as oil entered coastal areas and contacted shore. Potential impacts reflect the spill and response in very shallow coastal waters and once along the shoreline. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in the potential exposure of the resources throughout various life cycle stages.

The major impact-producing factors resulting from the low-probability catastrophic event at may affect the five terrapin subspecies that occur in the WPA and CPA include offshore and coastal oil spills and spill-response activities.

Terrapins inhabit brackish waters including coastal marshes, tidal flats, creeks, and lagoons behind barrier beaches (Hogan, 2003). Their diet consists of fish, snails, worms, clams, crabs, and marsh plants (Cagle, 1952). Courtship and mating occur in March and April, and the nesting season extends through July, with possibly multiple clutches (U.S. Dept. of the Army, COE, 2002; Butler et al., 2006). Terrapins nest on dunes, beaches, sandy edges of marshes, islands, and dike roads (Roosenburg, 1994). The common factor for proper egg development is sandy soil, which does not clog eggshell pores, thus allowing sufficient gas exchange between the developing embryo and the environment (Roosenburg, 1994). Nesting occurs primarily in the daytime during high tide on high sand dunes with gentle slopes and minimal vegetation (Burger, 1977). Clutch size ranges from 4 to 22 eggs, and incubation time ranges from 61 to 104 days (Butler et al., 2006; Burger, 1977). Female terrapins may nest 2-3 times in the same nesting season. Gender determination is temperature dependent. Hatching occurs from July through October in northeastern Florida (Butler et al., 2004).

Spending most of their lives at the aquatic-terrestrial boundary in estuaries, terrapins are susceptible to habitat destruction from oil-spill cleanup efforts as well as direct contact with oil. However, most impacts cannot be quantified at this time. Even after oil is no longer visible, terrapins may still be exposed while they forage in the salt marshes lining the edges of estuaries, where oil may have accumulated under the sediments and within the food chain. Terrapin nests can also be disturbed or destroyed by cleanup efforts. The range of the possible chronic effects from contact with oil and dispersants include lethal or sublethal oil-related injuries that may include skin irritation from the oil or dispersants, respiratory problems from the inhalation of volatile petroleum compounds or dispersants, gastrointestinal problems caused by the ingestion of oil or dispersants, and damage to other organs because of the ingestion or inhalation of these chemicals.

Accidental blowouts, oil spills, and spill-response activities resulting from a CPA proposed action have the potential to impact small to large numbers of terrapins within their habitat, 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 terrapins in the Gulf may be exposed to residuals of oils spilled as a result of a CPA proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to terrapins occurring in the GOM. In the most likely scenarios, exposure to hydrocarbons persisting within the wetlands following the dispersal of an oil slick could result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease). Terrapin hatchling exposure to, fouling by, or consumption of tarballs persisting inland following the dispersal of an oil slick could likely be fatal but unlikely. Impacts from the dispersants are unknown, but they may have similar irritants to tissues and sensitive membranes as are known to occur in seabirds and sea turtles (NRC, 2005). The impacts to diamondback terrapins from chemical dispersants could include nonlethal injury (e.g., tissue irritation and inhalation), long-term exposure through bioaccumulation, and potential shifts in distribution from some habitats.

Burger (1994) described the behavior of 11 female diamondback terrapins that were oiled during the January 1990 spill of No. 2 fuel oil in Arthur Kill, New York. The terrapins were hibernating at the time of the spill, and when they emerged from hibernation, they were found to be oiled. The terrapins voided oil from their digestive tracks for 2 weeks in rehabilitation. At 3 weeks, the terrapins scored low on strength tests and were slow to right themselves when placed on their backs. At 4 weeks, they developed edema and appetite suppression. Eight of the 11 died; these animals had traces of oil in their tissues and exhibited lesions in their digestive tract consistent with oil exposure (Burger, 1994). Further detail on this catastrophic OSRA run is contained in **Appendix C**.

The *Deepwater Horizon* explosion, oil spill, and response may have potentially impacted the terrapin community. Impacts from a catastrophic spill may impact terrapin communities. Impacts can be either direct (mortality or injury) or indirect (e.g., reduced prey availability); however, most impacts cannot be quantified at this time. The best available information does not provide a complete understanding of the effects of the spilled oil and active response/cleanup activities on the potentially affected terrapin environment. Current available information includes photographic evidence of one terrapin found oiled on Grand Terre Island, Louisiana, on June 8, 2010 (State of Louisiana, Coastal Protection and Restoration, 2012).

Phase 4—Post-Spill, Long-Term Recovery and Response

Phase 4 focuses on long term recovery once the well has been capped and the spill has stopped. During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and cleanup activities are concluding. While it is assumed that the majority of spilled oil would be dissipated offshore within 1-2 months (depending on season and temperature) of stopping the flow, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill. On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms. Potential impacts reflect long term persistence of oil in the environment and residual and long-term cleanup efforts.

The *Deepwater Horizon* explosion, oil spill, and response and associated oil spill may have impacted the terrapin community and associated brackish habitats. According to OSAT-2 (2011), possible environmental effects from the *Deepwater Horizon* explosion, oil spill, and response could occur within terrapin marsh habitat via food or to nesting habitat since no active intervention (natural remediation) is the preferred protocol.

Habitat destruction, road construction, drowning in crab traps, and nest predation are the most recent threats to diamondback terrapins. Tropical storms, hurricanes, and beach erosion threaten their preferred nesting habitats. Destruction of the remaining habitat because of a catastrophic spill and response efforts could drastically affect future population levels and reproduction.

Overall Summary and Conclusion (Phases 1-4)

Impacts on diamondback terrapins from smaller accidental events are likely to affect individual diamondback terrapins in the spill area, as described above, but are unlikely to rise to the level of population effects (or significance) given the probable size and scope of such spills. Possible catastrophic environmental effects from an oil spill and cleanup could occur within terrapin marsh habitat via food or to the nesting habitat. Since terrapins do not move far from where they are hatched, it is possible that entire subpopulations could incur high mortality rates and community disruptions, though this would be highly localized depending on the time, place, and size of the spill.

The OSRA analyses in this Supplemental EIS conclude that there is a low probability for catastrophic spills and that there is a potential for a low-probability catastrophic event to result in significant, population-level effects on affected diamondback terrapin species.

For those terrapin populations that may not have been impacted by the *Deepwater Horizon* explosion, oil spill, and response, it is unlikely that a future accidental event related to a CPA proposed action would result in significant impacts due to the distance of most terrapin habitat from offshore OCS energy-related activities.

B.3.1.15. Beach Mice

Phase 1—Initial Event

There would likely be no adverse impacts to beach mice as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because Phase 1 is the initiation of a catastrophic blowout incident, and initiation would occur well offshore from beach mouse habitat.

Phase 2—Offshore Spill

There would likely be no adverse impacts to beach mice as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters away from beach mouse habitat.

Phase 3—Onshore Contact

Five subspecies of the field mouse, collectively known as beach mice, live along the Gulf Coast, and two beach mouse subspecies live on the Atlantic Coast of Florida. Five subspecies of beach mice (Alabama, Perdido Key, Choctawhatchee, St. Andrew, and Anastasia Island) are listed as State and federally endangered; also, the southeastern beach mouse is listed as federally threatened. Beach mice are restricted to the coastal barrier sand dunes along the Gulf Coasts of Alabama and Florida. Erosion caused by the loss of vegetation because of oiling would likely cause more damage than the direct oiling of beach mice because of the degradation or loss of habitat. In addition, vehicular traffic and activity associated with cleanup can trample or bury beach mice nests and burrows or cause displacement from preferred habitat. Improperly trained personnel and vehicle and foot traffic during shoreline cleanup of a catastrophic spill would disturb beach mouse populations and would degrade or destroy habitat.

The Alabama, Choctawhatchee, St. Andrew, Perdido Key, Anastasia Island, and southeastern beach mice are designated as protected species under the Endangered Species Act, mostly because of the loss and fragmentation of coastal habitat (*Federal Register*, 1989; USDOI, MMS, 2007). Some of the subspecies have coastal habitat that is designated as their critical habitat. For example, the endangered Alabama beach mouse's (*Peromyscus polionotus ammobates*) designated critical habitat is 1,211 acres (450 hectares) of frontal dunes covering just 10 mi (16 km) of shoreline (USDOI, FWS, 2007). Critical habitat is the specific geographic areas that are essential for the conservation of a threatened or endangered species.

All designated critical habitat for beach mice officially extends landward from the mean high water line (*Federal Register*, 2006; USDOI, FWS, 2007). Therefore, spilled oil could contact critical habitat even without a concurrent storm surge; contact would require only that the water level would be at mean high tide. However, a concurrent storm surge of considerable height would be required to oil the portion of the critical habitat substantially landward of the mean high water line (over the tops of the primary, secondary, and tertial dunes). With the potential oiling of over 1,000 mi (1,609 km) of shoreline that could result from a catastrophic spill event and a concurrent storm surge of considerable height that occurs within a close proximity to the critical habitat, there is the potential for the entire critical habitat for a subspecies of beach mice to be completely oiled. Thus, destruction of critical habitat because of a catastrophic spill, a concurrent storm surge of considerable height and over a considerable length of shoreline, and cleanup activities would increase the threat of extinction of several subspecies of beach mice. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Phase 4—Post-Spill, Long-Term Recovery and Response

Within the last 20-30 years, the combination of habitat loss because of beachfront development, the isolation of the remaining beach mouse habitat areas and populations, and the destruction of the remaining habitat by tropical storms and hurricanes has increased the threat of extinction of several subspecies of beach mice. On sandy beaches, oil can sink deep into the sediments and become exposed again after erosion of sand by wave action. Oil may therefore persist near beach mouse habitat for the long term. The destruction of the remaining habitat because of a catastrophic spill and cleanup activities would increase the threat of extinction.

Overall Summary and Conclusion (Phases 1-4)

Impacts to beach mice would vary according to the severity of the oiling. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

B.3.1.16. Coastal, Marine, and Migratory Birds

Phase 1—Initial Event

Some migratory birds use offshore platforms or rigs as potential stopover sites during their long-distance migrations across the GOM during the spring and fall (Russell, 2005). In addition, it has been well documented that seabirds are attracted to offshore platforms and rigs for a myriad of reasons; i.e., concentrations of baitfish, roost sites, etc. (Tasker et al., 1986; Wiese et al., 2001; Burke et al., 2012). The numbers of birds present at a platform or rig tend to be greater on platforms or rigs closer to shore, particularly during drilling operations (Baird, 1990). Birds resting on the drilling rig or platform during a catastrophic blowout at the surface (similar to the *Deepwater Horizon* explosion, oil spill, and response) are more likely to be killed by the explosion. While it is assumed that most birds in trans-Gulf migration would likely avoid the fire and smoke plume during the day, it is possible that the light from the fire could interfere with nocturnal migration, especially during poor visibility conditions, i.e., fog or low clouds. It has been documented that seabirds are attracted to natural gas flares at rigs and platforms (Russell, 2005; Wiese et al., 2001); therefore, additional bird fatalities could result from the fire following the blowout. Though different species migrate differentially throughout the year, the largest number of species migrates through the proposed area from mid-April through mid-May (spring migration back north) and from mid-August through early November (fall migration south) (Russell, 2005, Table 6.12; Farnsworth and Russell, 2007). A blowout during this time would potentially result in a greater number of bird fatalities (see below).

Of the four phases considered herein, avian mortality associated with this Phase is certainly expected to be much lower than avian mortality associated with either Phase 2 or Phase 3. However, this anticipated result is highly dependent on the location of the platform and the timing of the event. The only scenario considered is the case where a blowout and explosion occurred at the surface (**Table B-4**). If the catastrophic event, in this case a blowout and explosion at the surface (refer to **Table B-4**), occurs more proximal to the coast during the breeding season or during a peak migration period (late March to late May and mid-August to early November), then the level of avian mortality is expected to be higher. In comparison, a blowout and explosion at the surface on a platform more distant from the coast (greater than or equal to the distance of the *Macondo* well from the coast) would result in much lower avian mortality, particularly if the event did not overlap temporally with either the breeding season or either of the trans-Gulf migrations.

While the species composition and species-specific mortality estimates are unknown and would be dependent on the blowout location and time of year, the initial mortalities would almost certainly not result in population-level impacts for species present at the time of the blowout and resulting fire (Arnold and Zink, 2011; also refer to Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS). If the event occurred during the breeding season or wintering period, species of seabirds or diving birds would have the greatest potential to be affected, whereas if the event occurred during either the spring or fall migration, species of passerines would most likely have the greatest potential to be affected due to the diversity and sheer numbers of individuals in this avian species group (Rappole and Ramos, 1994; Lincoln et al., 1998; Russell, 2005; also refer to **Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS).

Phase 2—Offshore Spill

During Phase 2 of a catastrophic spill, the primary concern for marine and migratory birds would be their vulnerability to oiling or ingesting oil, which is primarily a function of their behavior and diets. Wading birds (e.g., herons, egrets, etc.) and species that feed by plunge-diving into the water to catch small fish (e.g., pelicans, gannets, terns, gulls, and pelagic birds) and those that use water as a primary means of locomotion, foraging (e.g., black skimmers), or resting and preening (e.g., diving ducks, cormorants, pelicans, etc.) are highly vulnerable to becoming oiled and also to ingesting oil (**Table B-5** of this Supplemental EIS; also refer to Table 4-13 and Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS). Seabirds, in particular, tend to feed and concentrate in convergence zones, eddies, upwellings, and near *Sargassum* mats (Haney, 1986a-c; Moser and Lee, 2012). In addition to concentrating prey, these areas are also known to aggregate oil (Unified Incident Command, 2010d). Oiling interferes with the birds' ability to fly (thus to obtain food) and compromises the insulative characteristics of down and contour feathers, making it difficult to regulate body temperature. Attempts by oiled birds to remove the oil via preening can cause them to ingest oil and may result in mortality. In addition, the ingestion of contaminated prey can result in physiological impairment and even death. Refer to Chapter 4.2.1.16.3 of the 2012-2017 WPA/CPA Multisale EIS for additional detailed information on oiling effects to birds.

Though several species or species groups are mentioned above, the most vulnerable species to spilled oil in the offshore environment in the GOM during Phase 2 would be representatives of the diving bird (≤10 species) and seabird (≥20 species) groups (King and Sanger, 1979; Ribic et al., 1997; Davis et al., 2000). Unlike Phase 1, where passerines may be affected depending on the timing of the catastrophic event, timing or seasonal effects would be less important under the Phase 2 scenario (**Table B-4**) due to the spilled oil being restricted to the offshore environment, thereby limiting the potential impacts to the several avian species groups relegated to the coastal and nearshore environment (**Table B-5** of this Supplemental EIS; also refer to **Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS). However, it is highly probable that representative species of diving birds and seabirds would differentially be impacted (**Table B-5** of this Supplemental EIS; also refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS). Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS shows the actual number of birds identified to the species level for each of the species groups. This number is fairly representative of the suite of species available to be oiled. However, this number is dependent on efforts to correctly assign species to unidentified birds or unknowns, which is also a function of search effort. Search effort likely declined dramatically once the *Macondo* well was plugged/capped. The species composition and species-specific mortality estimates associated with a Phase 2 catastrophic event are unknown and would be dependent primarily on the blowout location, as well as the distribution, coverage, and proximity to the shoreline of spilled oil. Overall, avian mortalities for this Phase would probably not result in population-level impacts for species present at the time of the blowout (refer to **Table B-5** of this Supplemental EIS and to Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS). However, it should be clear that many species of seabirds and diving birds have life-history strategies that do not allow subpopulations to recover quickly from major mortality events or perturbations (Ricklefs, 1983 and 1990; Russell, 1999; Saether et al., 2004; also refer to Table 4-13 and Figure 4-18 of the 2012-2017 WPA/CPA Multisale EIS).

Some discussion of available information provided from the *Deepwater Horizon* explosion, oil spill, and response is relevant here with respect to temporal aspects of oiled birds (**Figure B-3**). The first oiled bird (northern gannet, a seabird) recovered after the *Macondo* well event was collected just 10 days post-blowout. While gannets breed in coastal colonies in the Canadian North Atlantic, the population, including a major concentration in the northern GOM, over-winters in the deeper waters of the offshore environment. Belanger et al. (2010) provided some interesting results relative to live versus dead birds collected based on the actual date each bird was collected. Interestingly, they documented a dramatic and statistically significant decline in the number of live birds collected after 110 days compared with live birds collected during the first 72 days. These authors also documented a dramatic and statistically significant increase in the number of dead birds collected after 110 days (Belanger et al., 2010, Figures 2 and 3). As a temporal reference, oil reached the shoreline near Venice, Louisiana, ≥10 days post-blowout, covering a distance of approximately 90 mi (145 km) (Oil Spill Commission, 2011; also refer to Chapter 4.2.1.3.1 of the 2012-2017 WPA/CPA Multisale EIS and Chapter 4.2.1.3 of the WPA 233/CPA 231 Supplemental EIS) (**Figure B-3**). It should be understood that, for the Phase 2 scenario considered here, it is assumed that spilled oil will not contact the shoreline.

Overall, avian mortality estimates are unknown and are difficult to predict given the uncertainty (Conroy et al., 2011, pages 1209-1210; Williams, 2011, page 1348) associated with the scenario and specific characteristics associated with the spill (refer to **Appendix C**), as well as environmental conditions that are probably a function of spill location and timing. Even recognizing the uncertainty associated with the scenario, spill characteristics, and the environmental conditions at the time of the spill, Phase 2 would likely be second only to Phase 3 in total avian mortality. Phase 3 would include much greater avian species diversity and abundance due to the oil reaching nearshore, coastal beach/dune, salt- and brackish marsh habitats (**Table B-5** of this Supplemental EIS; also refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS).

Phase 3—Onshore Contact

Gulf coastal habitats are essential to the annual cycles of many species of breeding, wintering, and migrating diving birds, seabirds, shorebirds, passerines, marsh- and wading birds, and waterfowl (refer to **Chapter 4.1.1.16** of this Supplemental EIS, Chapter 4.2.1.16.1 of the 2012-2017 WPA/CPA Multisale EIS, and Chapter 4.2.1.16 of the WPA 233/CPA 231 Supplemental EIS). For example, the northern Gulf Coast supports a large proportion of populations of several beach-nesting bird species (USDOI, FWS, 2011b). During Phase 3, oil is expected to contact not only the beach but also other important habitats used by a diverse and abundant assemblage of avian species. Habitats potentially impacted by a catastrophic spill would also likely include the nearshore environment, as well as the salt- and brackish marsh habitats. Potential impacts and total avian mortality from Phase 3 would be greater than any of the other phases considered herein due to (1) avian diversity and abundance in the nearshore environment (**Table B-5** of this Supplemental EIS; also refer to Tables 4-9 through 4-11 of the 2012-2017 WPA/CPA Multisale EIS) and (2) the dispersion of oil from a catastrophic spill, which would reach the shoreline and enter the salt- and brackish marsh environments. Similar to Phases 1 and 2, the timing and location of the spill are important factors in determining the severity of impacts to the avian community. In addition, the duration of potential oil exposure to various species of birds would also be important.

As the *Macondo* well blowout and spill is the only historic catastrophic oil spill to occur in U.S. waters in the GOM, the information obtained from the *Deepwater Horizon* explosion, oil spill, and response relative to avian mortality may be reasonably relevant for any future catastrophic spills, recognizing of course the variation and uncertainty associated with individual oil spills. At present, the estimates of avian mortality associated with the *Exxon Valdez* oil spill far exceed current estimates of avian mortality associated with the *Deepwater Horizon* explosion, oil spill, and response even though the *Deepwater Horizon* spill volume/size far exceed that of the *Exxon Valdez* (refer to Table 4-15 of the

2012-2017 WPA/CPA Multisale EIS). Based on data from the *Deepwater Horizon* explosion, oil spill, and response, a similar catastrophic spill would probably result in >10,000 carcasses collected (*Deepwater Horizon* explosion, oil spill, and response = 7,258 collected) representing >100 potentially impacted species (*Deepwater Horizon* explosion, oil spill, and response = 104 species identified) (refer to **Table B-5**, superscript 1 and also superscript b). It should be recognized that the number of avian carcasses collected post-spill represents some unknown fraction or proportion of the total modeled estimate of realized mortality (Flint et al., 1999; Byrd et al., 2009; Ford and Zafonte, 2009); the number of avian carcasses collected is biased low (Piatt et al., 1990a-b; Piatt and Ford, 1996; Castege et al., 2007). Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS should provide reasonable estimates of oiling rates for the seven avian species groups in the northern Gulf of Mexico if another catastrophic spill were to occur and the timing, oil spill characteristics, and spill behavior were similar to the *Deepwater Horizon* explosion, oil spill, and response. It should be noted that the top five most impacted (based on number collected) avian species from the *Deepwater Horizon* explosion, oil spill, and response were all representatives of the seabird group: laughing gull (n = 2,981, 40% oiling rate); brown pelican (n = 826, 41% oiling rate); northern gannet (n = 475, 63% oiling rate); royal tern (n = 289, 52% oiling rate); and black skimmer (n = 253, 22% oiling rate) (**Table B-5** of this Supplemental EIS and Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS).

Additional information is provided herein from an OSRA catastrophic oil-spill analysis (refer to **Appendix C, Tables C-4 and C-5**).

It should be noted that oil from the *Deepwater Horizon* explosion and oil spill reached the shoreline less than 14 days after the blowout occurred (Oil Spill Commission, 2011). The OSRA does not take into account or consider the following with respect to avian resources and their habitats: (1) species-specific densities; (2) species-specific habitat preferences, food habits, or behavior; (3) relative vulnerabilities to oiling among the avian species groups or among species within each of the groups (**Table B-5** of this Supplemental EIS and Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS; also refer to Williams et al., 1995; Camphuysen, 2006); and (4) it does not take into account or consider species-specific life-history strategies, their demography, or a species' recovery potential (refer to Table 4-13 and Figures 4-18 and 4-19 of the 2012-2017 WPA/CPA Multisale EIS).

In summary, Phase 3 of a catastrophic oil spill has the greatest potential for negative impacts (i.e., direct mortality) to avian resources due to its contact with the shoreline and inundation of other habitats occupied by a much greater diversity and abundance of birds, particularly during the breeding season. Avian mortality estimates are presently unknown and are difficult to predict with any level of precision given the uncertainty associated with the scenario, specific characteristics associated with the spill, spatial and temporal variation in environmental conditions, and recognition that the avian resources (both species diversity and abundance) available to be oiled will also vary temporally and spatially. A worst-case scenario in the event of a catastrophic oil spill that reached the nearshore environment would occur in the presence of a hurricane with strength or magnitude similar to Hurricanes Katrina, Rita, or Ike during the breeding season. Such an overlap of two low-probability events during the breeding season could potentially push spilled oil even farther inland and also distribute oil vertically into the vegetation. Such an event would not only negatively impact diving birds, seabirds, shorebirds, marsh- and wading birds, and waterfowl but also the more terrestrial avian species groups including passerines and raptors. Such effects would most likely be long-term (due to direct mortality of individuals, but also due to major habitat loss) and could potentially result in population-level impacts to a number of avian species. Threatened and endangered avian species would likely be the most severely impacted by such an event depending on the spatial and temporal aspects of both the spill and the hurricane.

Endangered and Threatened Birds

A detailed discussion of threatened and endangered species is provided in Chapter 4.2.1.16.1 of the 2012-2017 WPA/CPA Multisale EIS. Of the 17 species considered, 11 species are known to occur in the CPA (**Table B-6**). However, only the piping plover (*Charadrius melodus*), roseate tern (*Sterna dougallii dougallii*), wood stork (*Mycteria americana*), whooping crane (*Grus americana*), Mississippi sandhill crane (*Grus canadensis pulla*), bald eagle (*Haliaeetus leucocephalus*), eastern brown pelican (*Pelecanus occidentalis*), and red knot (*Calidris canutus rufa*) were analyzed and are considered further here. Phase 3 would likely result in the greatest net negative impacts (primarily direct mortality) to threatened and endangered avian species due to contact with the shoreline and potential movement of spilled oil inland to other habitats during this phase (**Table B-4**). In addition, the presence of spilled oil would result in indirect and potentially long-term effects to threatened and endangered avian species' habitats and their preferred foods. Phases 1 and 2 would likely result in very limited impacts, if any, due to the scenarios as defined with oil restricted to the offshore environment.

In general, the potential direct impact (i.e., mortality) to any or all of these threatened or endangered (including recently delisted and candidate) species is directly a function of their presence at the time of a catastrophic oil spill. Indirect effects from a catastrophic oil spill could negatively affect the quality and functional availability of their habitats and the availability, distribution, and energetic benefits of their preferred foods in the absence of a given species. Of the species listed, the wood stork, Mississippi sandhill crane, bald eagle, eastern brown pelican, and Cape Sable seaside sparrows are year-round residents, whereas the piping plover, roseate tern, whooping crane, and red knot represent either wintering species or transients that utilize coastal habitats in the GOM as staging areas during migration. There are "resident" whooping cranes considered as "nonessential, experimental flocks" within the Gulf Coast States of Alabama, Louisiana, Mississippi, and Florida. These birds would be considered as "resident," whereas the component of the ESA-listed species occurring primarily as a wintering flock in Texas (i.e., the Aransas National Wildlife Refuge) is considered a migratory flock. It is important to recognize these differences relative to whether or not individuals of a given species would be present and available to be oiled should a catastrophic oil spill event occur. Similarly, species-specific differences in habitat use and behavior would further separate which species would be most vulnerable to a spill given the timing of the spill, spill distribution, and other spill-related characteristics.

Of the species considered, probably only the eastern brown pelican and possibly the bald eagle (ingestion of contaminated fish and birds) would potentially be impacted during Phases 1 and 2. The other species are restricted to the nearshore, coastal, salt- and brackish, and upland habitats, which would not be impacted during these phases given the scenario (**Table B-4**). Phase 4 impacts to threatened and endangered avian species would probably be limited to short-term disturbance-related effects and potential impacts to habitats including destruction, alteration, or fragmentation from associated recovery activities (ABC, 2010; NASI, 2010).

As the *Macondo* well blowout and spill is the only historic catastrophic oil spill to occur in U.S. waters in the GOM, the information obtained from the *Deepwater Horizon* explosion, oil spill, and response relative to avian mortality may be reasonably relevant for any future catastrophic spills, recognizing of course the variation and uncertainty associated with individual oil spills. Of the threatened and endangered avian species considered, only a single, unoiled piping plover was collected as part of the post-*Deepwater Horizon* explosion, oil spill, and response monitoring program (**Table B-5**). There were 106 least terns (*Sterna antillarum*) collected (n = 106, 46% oiling rate), but these individuals were considered as members of the coastal breeding population and not the ESA-listed population (Interior or noncoastal population). Of the species considered, only the eastern brown pelican was impacted by the *Deepwater Horizon* explosion, oil spill, and response (n = 826, 41% oiling rate); this species was delisted on November 17, 2009 (*Federal Register*, 2009). No other carcasses of threatened and endangered species were collected as part of the post-*Deepwater Horizon* explosion, oil spill, and response monitoring efforts (**Table B-5**; USDOI, FWS, 2011b).

Additional information is provided herein from an OSRA catastrophic oil-spill analysis (refer to **Appendix C**, **Tables C-4 and C-5**).

Caveats regarding the OSRA catastrophic run with respect to avian resources were addressed above and would also apply to threatened and endangered avian resources considered here.

Phase 4—Post-Spill, Long-Term Recovery and Response

There is a high probability of underestimating the impacts of oil spills on avian species potentially encountering oil. Despite being oiled, some birds are capable of flight and may later succumb to the oiling for a myriad of reasons (refer to Chapter 4.2.1.16 of the 2012-2017 WPA/CPA Multisale EIS for additional detailed information). Often overlooked and understudied are the long-term, sublethal, chronic effects due to sublethal exposure to oil (Butler et al., 1988; Alonso-Alvarez et al., 2007; Pérez et al., 2010). Also, individuals having been oiled in the Gulf of Mexico as the result of a catastrophic oil spill during the overwinter period or while staging in the GOM could exhibit carry-over effects to the northern breeding grounds. Affected individuals in poor body condition may arrive at their breeding grounds later than nonaffected individuals, which could, in turn, negatively affect habitat-use decisions, territory establishment, pairing success, and ultimately lead to reduced reproductive success (Norris, 2005 and 2006; Harrison et al., 2011; Mitchell et al., 2011). Some oiled individuals may forego breeding altogether (Zabala et al., 2010). If oil-affected, long-distance migrants represent important prey items for various species of raptors, then the ingestion of affected individuals could also negatively affect individual birds of prey (Zuberogoitia et al., 2006). Refer to Henkel et al. (2012) for a review of potential carry-over effects to shorebirds potentially impacted by the *Deepwater Horizon* explosion, oil spill, and response.

The long-term impacts of potential food-induced stress for bird species from an altered ecosystem due to a catastrophic spill are unknown, but disturbances to the ecosystem can cause long-term sublethal impacts, including reduced food intake, prey switching, increased energy expenditures, decreased reproductive success, and decreased survival. Decreases in either reproductive success or survival (or both) could result in population-level effects as was observed for certain avian species more than 10 years after the *Exxon Valdez* catastrophic spill (Esler et al., 2002, 2010; Golet et al., 2002). Long-term, sublethal, chronic effects may exceed immediate losses (i.e., direct mortality of oiled birds) if residual effects influence a significant proportion of the population or disproportionately impact an important aspect of the population demographic, i.e., breeding-age females (Croxall and Rothery, 1991; Oro et al., 2004; Aubry et al., 2011). Depending on the effects and the life-history strategy of impacted species, some populations could take years or decades before reaching pre-spill population numbers and age-sex structure; some populations for some species may never recover (refer to Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS; refer to Peterson et al., 2003, but also to Wiens et al., 2010).

In general, potential effects associated with Phase 4 should be limited to short-term disturbance effects (personnel and equipment) and potential indirect effects to various avian species groups due to habitat loss, alteration, or fragmentation from restoration efforts. There may be cases whereby incubating individuals are flushed from nests exposing their eggs or young to either weather-related mortality or depredation by avian or mammalian predators (American Bird Conservancy, 2010; National Audubon Society, Inc., 2010). However, efforts to minimize potential effects of post-oil spill monitoring and restoration efforts, particularly during the breeding season, should be sufficient to protect nesting birds as a function of oversight by Federal and State agencies charged with the conservation of migratory bird resources.

Limited information available to date with respect to avian impacts from the *Deepwater Horizon* explosion, oil spill, and response suggests much lower mortality than would have been predicted by the spill size or volume alone (Belanger et al., 2010), though spill volume or size tends to be a poor predictor of avian mortality (Burger, 1993; Tan et al., 2010). The final modeled estimates of avian mortality will greatly exceed the number of avian carcasses collected (n = 7,258; **Table B-5**), but overall, the *Deepwater Horizon* explosion, oil spill, and response appears to have directly resulted in far fewer dead, oiled birds than the *Exxon Valdez* catastrophic spill (refer to Table 4-15 of the 2012-2017 WPA/CPA Multisale EIS). It should be recognized that the avian-related mortality associated with the *Deepwater Horizon* explosion, oil spill, and response (considered a catastrophic event) represents a small fraction of birds killed when compared with collisions with offshore oil and gas platforms. Russell (2005, page 304) states, "an average Gulf platform may cause 50 deaths by collision [only] per year," so using this number, the number of deaths the *Deepwater Horizon* rig would have caused through collisions had it remained intact for its 40-year term would be about 2,000. That is about 5,258 less than the number of avian carcasses collected due to the *Deepwater Horizon* explosion, oil spill, and response just given above. In the GOM, an estimated 200,000-321,000 avian deaths occur annually; primarily due to collisions with platforms (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS; also refer to Russell, 2005). Over the life of the GOM platform archipelago, the estimated total avian mortality is on the order of 7-12 million birds (refer to Figure 4-15 of the 2012-2017 WPA/CPA Multisale EIS). Oil spills, regardless of size, are but one of a myriad of anthropogenic avian mortality sources. Even the cumulative total avian mortality associated with all the North American oil spills to date is only a small fraction when compared with estimates of annual avian mortality attributed to collisions with buildings and windows, predation by housecats, and collisions with powerlines and communication towers (Klem, 2009; Manville, 2009; Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS).

Overall Summary and Conclusion (Phases 1-4)

While the species composition and species-specific mortality estimates are unknown and would be dependent on the blowout location and time of year, the mortalities for the initial event (Phase 1) would almost certainly not result in population-level impacts for species present at the time of the blowout and resulting fire. Seabirds are highly vulnerable to becoming oiled and also to ingesting oil during Phase 2 (the offshore spill). Even recognizing the uncertainty associated with the scenario, spill characteristics, and the environmental conditions at the time of the spill, Phase 2 would likely be second only to Phase 3 (onshore contact) in total avian mortality. Phase 3 would include impacts to much greater avian species' richness and abundance (particularly during the breeding season) due to oil reaching habitats, including the nearshore, coastal beaches and dunes, and salt and brackish marshes. In general, the potential effects associated with Phase 4 (long-term recovery and response) should be limited to short-term disturbance effects (by cleanup personnel and equipment) and potential indirect effects to various bird species groups from habitat loss, alteration, or fragmentation from restoration efforts.

Phases 1 (initial event) and 2 (offshore spill) would likely result in very limited impacts to threatened and endangered bird species because the two scenarios have oil restricted to the offshore environment. Phase 3 (onshore contact) would likely result in the greatest net negative impacts to threatened and endangered bird species due to contact with the shoreline and potential movement of spilled oil inland to other habitats during this phase.

B.3.1.17. Fish Resources and Essential Fish Habitat

Phase 1—Initial Event

Depending on the type of blowout and the proximity of marine life to it (**Table B-1**), an eruption of gases and fluids may generate not only a toxic effect but also pressure waves and noise significant enough to injure or kill local biota. Within a few thousand meters of the blowout, resuspended sediments may clog fish gills and interfere with respiration. Settlement of resuspended sediments may, in turn, smother invertebrates or interfere with their respiration. Essential fish habitat (EFH) in the vicinity of the blowout could have adverse effects from the event. These EFH resources are discussed in the water quality (**Chapter B.3.1.1.2**), live bottoms (**Chapter B.3.1.1.6**), topographic features (**Chapter B.3.1.1.7**), *Sargassum* communities (**Chapter B.3.1.1.8**), chemosynthetic and nonchemosynthetic deepwater benthic communities (**Chapters B.3.1.1.9 and B**.3.1.1.**10**, respectively), and soft bottom benthic communities (**Chapter B.3.1.1.11**) chapters.

Phase 2—Offshore Spill

With the initiation of a catastrophic blowout incident, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, this could result in a fire that would burn for 1 or 2 days, but if a blowout occurs on a production platform and other wells feed the fire, it could burn for over a month. The drilling rig or platform may sink, and if this occurs in shallow water, the sinking rig or platform may land in the immediate vicinity. If the blowout occurs in deep water, the rig or platform could land a great distance away and could be beyond avoidance zones. Regardless of water depth, the immediate response would be from search and rescue vessels and aircraft, such as USCG cutters, helicopters, rescue planes, and firefighting vessels.

Early life stages of animals are usually more sensitive to oil than adults (Boesch and Rabalais, 1987; NRC, 2005). Weathered crude oil has been shown in laboratory experiments to cause malformation, genetic damage, and even mortality at low levels in fish embryos of Pacific herring (Carls et al., 1999). Because natural crude oil found in the Gulf of Mexico would generally float on the surface, fish species whose eggs and larvae are found at or near the water surface are most at risk from an offshore spill. Species whose spawning periods coincide with the timing of the highest oil concentrations would be at greatest risk.

Adult fish may be less at risk than earlier life stages, in part because they are less likely to concentrate at the surface and may avoid contact with floating oil. The effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes (internal lesions), the effects from direct coating by oil (suffocation by coating gills), incorporation of hydrocarbons in organisms (tainting or accumulation in the food chain), and changes in biological habitat (decreased dissolved oxygen) (Moore and Dwyer, 1974). The extent of the impacts of the oil would depend on the properties of the oil and the time of year of the event.

If there is a subsea catastrophic blowout, it is assumed dispersants would be used. Then there could be effects on multiple life history stages and trophic levels. There is limited knowledge of the toxicity of dispersants mixed with oil to specific species or life stages of ichthyoplankton and the likely extent of mortality because the combination of factors is difficult to determine. The combined toxic effects of the oil and any dispersants that may be used would not be apparent unless a significant portion of a year-class is absent from next year's fishery (e.g., shrimps, crabs, snapper, and tuna). The North Atlantic bluefin tuna is an example of a fish/fishery in the Gulf of Mexico that could be at risk to lose a year-class. It has a relatively narrow peak spawning period in April and May and floating eggs. A catastrophic blowout during the spring season could cause a negative effect to this population. The Gulf of Mexico is one of only two documented spawning grounds for the Atlantic bluefin tuna; the other is in the Mediterranean Sea and spawning is clustered in a specific type of habitat along the continental slope. While the western Atlantic stock has suffered and a long-term rebuilding plan has failed to revive the population or the fishery, NOAA made a determination on May 27, 2011, that Atlantic bluefin tuna did not warrant species protection under the ESA at that time. The NOAA does plan to revisit this decision by 2013 when more information will be available concerning any effects of the *Deepwater Horizon* explosion, oil spill, and response. In addition, a new stock assessment will be available from the International Commission for the Conservation of Atlantic Tunas.

An example of a catastrophic event in the CPA was modeled using OSRA (**Appendix C, Tables C-4 and C-5**). Because fish occur throughout the GOM, it is assumed that some individuals would be contacted with oil. Specific habitats that are discussed with regards to the Western Planning Area OSRA example and in the Appendix are water quality (**Chapter B.3.1.1.2**), wetlands (**Chapter B.3.1.1.4**), seagrass communities (**Chapter B.3.1.1.5**), live bottoms (**Chapter B.3.1.1.6**), topographic features (**Chapter B.3.1.1.7**), *Sargassum* communities (**Chapter B.3.1.1.8**), chemosynthetic and nonchemosynthetic deepwater communities (**Chapters B.3.1.1.9 and B.3.1.1.10**, respectively), and soft bottom benthic communities (**Chapter B.3.1.1.11**).

Studies by USEPA, Office of Research and Development (2010) using representative species provide some indication of the relative toxicity of Louisiana sweet crude oil, dispersants, and oil/dispersant mixes. Bioassays were conducted using two Gulf species—a mysid shrimp (*Amercamysis bahia*) and a small estuarine fish, the inland silverside (*Menidia beryllinina*)—to evaluate the acute toxic effects of oil, eight dispersants, and oil/dispersant mixtures. In addition, USEPA used standard *in vitro* techniques using the same dispersants to (1) evaluate the acute toxicity on three cell lines over a range of concentrations and (2) evaluate the effects of these dispersants on androgen and estrogen function using human cell lines (to see if they are likely to disrupt hormonal systems). All dispersants showed cytotoxicity in at least one cell type at concentrations between 10 and 110 ppm. Results of the *in vitro* toxicity tests were similar to the whole animal tests. For all eight dispersants, for both species, the dispersants alone were less toxic than the dispersant/oil mixture. Louisiana sweet crude oil alone was determined to be more toxic to both the mysid shrimp and silverside fish than the dispersants alone. The results of the testing for disruption of androgen and estrogen function indicate that the dispersants do not show biologically significant endocrine activity via androgen or estrogen pathways (USEPA, Office of Research and Development, 2010).

The GOM waters out to 100 fathoms (182 m; 600 ft) have EFH's described and identified for managed species (GMFMC, 2005; USDOC, NOAA, 2009). There are Fisheries Management Plans for shrimp, red drum, reef fishes, coastal migratory pelagics, spiny lobsters, coral and coral reefs, and highly migratory species (GMFMC, 2004; USDOC, NOAA, 2009). These species could use the GOM for EFH at different life history stages. The Highly Migratory Species Fisheries Management Plan was recently amended to update EFH and Habitat Areas of Particular Concerns for the Atlantic bluefin tuna spawning area (USDOC, NOAA, 2009).

These EFH's in the Gulf of Mexico are discussed in various chapters of this Appendix: water column (**Chapter B.3.1.1.2**); wetlands (**Chapter B.3.1.1.4**); seagrass communities (**Chapter B.3.1.1.5**), live bottoms (**Chapter B.3.1.1.6**); topographic features (**Chapter B.3.1.1.7**), *Sargassum* communities (**Chapter B.3.1.1.8**); chemosynthetic and nonchemosynthetic deepwater benthic communities (**Chapters B.3.1.1.9 and B.3.1.1.10**, respectively), and soft bottom benthic communities (**Chapter B.3.1.1.11**); these EFH's are also summarized in **Appendix D**. There are current NTL's (NTL 2009-G39 and NTL 2009-G40) and stipulations that provide guidance and clarification of the regulations with respect to many of these biologically sensitive underwater features and areas and benthic communities, which are considered EFH.

Plankton

Open-water organisms, such as phytoplankton and zooplankton, are essential to the marine food web. They play an important role in regulating climate, contribute to marine snow, and are an important source of nutrients for mesopelagic and benthic habitats. Also, monthly ichthyoplankton collections over the years 2004-2006 offshore of Alabama have confirmed that peak seasons for ichthyoplankton concentrations on the shelf are spring and summer (Hernandez et al., 2010). If a catastrophic blowout occurs in the spring and summer, it could cause greater harm to fish populations and not just individual fish. Therefore, an offshore oil spill would not only have an impact on these populations but also on the species that depend on them.

The microbial community can also be affected by an offshore oil spill. The microbial loop is an essential part of the marine ecosystem. Changes in the microbial community because of an oil spill could have significant impacts on the rest of the marine ecosystem. However, several laboratory and field experiments and observations have shown that impacts to planktonic and marine microbial populations are generally short lived and do not affect all groups evenly, and in some cases stimulate growth of important species (Gonzalez et al., 2009; Graham et al., 2010; Hing et al., 2011).

Phase 3—Onshore Contact

It is estimated that shoreline oiling would last 1-5 months from a shallow-water catastrophic spill event and 3-4 months from a deepwater catastrophic spill. It is estimated that there would be contact to the shoreline within 30 days of the spill for both shallow-water and deepwater spill locations. Though response methods would be monitored, there would also be some impact from these efforts on contacted coastal habitats. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

The life history of estuarine-dependent species involves spawning on the continental shelf; the transportation of eggs, larvae, or juveniles back to the estuary nursery grounds; and migration of the adults back to the sea for spawning (Deegan, 1989; Beck et al., 2001). Estuaries in the Gulf of Mexico are extremely important nursery areas and are considered EFH for fish and other aquatic life (Beck et al., 2001). Oiling of these areas, depending on the severity, can destroy nutrient-rich marshes and erode coastlines that have been significantly damaged by recent hurricanes.

The Gulf of Mexico supports a wide variety of finfish, and most of the commercial finfish resources are linked either directly or indirectly to the estuaries that ring the Gulf of Mexico. Darnell et al. (1983) observed that the density distribution of fish resources in the Gulf was highest nearshore off of the central Gulf Coast. For all seasons, the greatest abundance occurred between Galveston Bay and the mouth of the Mississippi River. Oyster beds could be damaged by freshwater diversions that release tens of thousands of cubic feet of freshwater per second for months in an effort to keep oil out of the marshes. Adult oysters survive well physiologically in salinities from those of estuarine waters (about 7.5 parts per thousand sustained) to full strength seawater (Davis, 1958). While oysters may tolerate small changes in salinity for a few weeks, a rapid decrease in salinity over months would kill oysters. In the event of a catastrophic oil spill, at least 1 year's oyster production in the area receiving fresh water would be lost because of exposure to freshwater and/or oil.

Phase 4—Post-Spill, Long-Term Recovery and Response

In addition to possible small fish kills because of direct impacts (as described under Phases 2 and 3), a catastrophic spill could affect fish populations in the long term. Due to a catastrophic spill, a significant portion of a year class of fish could be absent from the following year's fishery, reducing overall population numbers. However, sublethal impacts, especially for long-lived species (e.g., snapper and grouper), could be masked by reduced fishing pressure because of closures. In addition healthy fish resources and fishery stocks depend on ideal habitat (EFH) for spawning, breeding, feeding, and growth to maturity. There could be long-term effects to coastal habitats from buried or sequestered oil becoming resuspended after a disturbance. Thus, a catastrophic spill that affects these areas could result in long-term impacts, including destruction to a portion of their natural habitats.

Overall Summary and Conclusion (Phases 1-4)

Depending on the type of blowout and the proximity of marine life to it, an eruption of gases and fluids may generate not only a toxic effect but also pressure waves and noise significant enough to injure or kill local biota and destroy habitat in the immediate vicinity (Phase 1). Adult fish may be less at risk than earlier life stages, in part because they are less likely to concentrate at the surface and may avoid contact with floating oil. Effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes (internal lesions), the effects from direct coating by oil (suffocation by coating gills), incorporation of hydrocarbons in organisms (tainting or accumulation in the food chain), and changes in biological habitat (decreased dissolved oxygen) (Phase 2). Estuaries in the Gulf of Mexico are extremely important nursery areas and are considered EFH for fish and other aquatic life (Beck et al., 2001). Oiling of these areas, depending on the severity, can destroy nutrient-rich marshes and erode coastlines that have been significantly damaged by recent hurricanes (Phase 3). Due to a catastrophic spill, a significant portion of a year class of fish could be absent from the following year's fishery, reducing overall population numbers. However, sublethal impacts, especially for long-lived species (e.g., snapper and grouper), could be masked by reduced fishing pressure because of closures (Phase 4).

B.3.1.18. Commercial Fisheries

Phase 1—Initial Event

The initial explosion and fire could endanger commercial fishermen in the immediate vicinity of the blowout. Although commercial fishing vessels in the area would likely aid in initial search-and-rescue operations, the subsequent fire could burn for over a month, during which time commercial vessels would be expected to avoid the area so as to not interfere with response activities. This could impact the livelihood and income of these commercial fishermen. The extent of the economic impact on the fishing community would depend largely on the season during which the blowout occurred, the depth of water in which it occurred, and its distance from shore.

Phase 2—Offshore Spill

The Gulf of Mexico is one of the largest producers of seafood in the continental United States. In 2010 the Gulf of Mexico provided 40 percent of the commercial fishery landings in the continental U.S. (excluding Alaska), with over 1.5 billion pounds valued at nearly $670 million (USDOC, NMFS, 2012d). Various commercial species are fished from State waters through the Exclusive Economic Zone and are found throughout the water column as well as at the surface and near the seafloor. Commercial species occupy many different habitats throughout the area, and many commercial species occupy different habitats during different life stages. Most commercial species spend at least part of their life cycles in the productive shelf and estuarine habitat. In the event of a catastrophic offshore spill, it is assumed that a large quantity of oil would be released daily whether this spill occurred in State or Federal waters. Although the oil would generally float, it is also assumed that dispersants would be used preventing much of the oil from reaching the surface.

As an example of the areas that could be affected by such a catastrophic oil spill in the CPA, two OSRA model runs were performed using three different launch points as described in **Chapter B.1.2.3**. The resulting tables show conditional probabilities (expressed as percent chance) of an oil spill contacting resources in the GOM for each launch point and for each season, the condition being that a spill is assumed to have occurred at the given location. Because the commercial species are so widespread over the GOM, all of the tables are referenced (**Appendix C, Tables C-4 and C-5)**.

Oil that is not volatilized, dispersed, or emulsified by dispersants has the potential to affect finfish through direct ingestion of hydrocarbons or ingestion of contaminated prey. Finfish are, however, mobile and generally avoid adverse conditions. Less mobile species or planktonic larval stages are more susceptible to the effects of oil and dispersants.

Actual effects of any oil that is released and comes in contact with populations of commercially important species will depend on the API gravity of the oil, its ability to be metabolized by microorganisms, and the time of year of the spill. The effects on the populations will be at a maximum during the spawning season of any commercially important population, exposing larvae and juveniles to oil. The effects on commercial species may also include tainting of flesh or the perception of tainting in the market. This can, depending on the extent and duration of the spill, affect marketability of commercial species.

Even though sensory testing may show no detectable oil or dispersant odors or flavors and the chemical test results could be well below the known levels of concern, NOAA Fisheries would be expected to close large portions of the Gulf of Mexico during a high-volume spill. This would be done as a precautionary measure to ensure public safety and to assure consumer confidence in Gulf seafood (USDOC, NMFS, 2010c. Up to 30-40 percent of the Gulf of Mexico's Exclusive Economic Zone could be closed to commercial fishing as the spill continues and expands (USDOC, NMFS, 2010d). This area could represent 50-75 percent of the Gulf's seafood production (Flynn, 2010). The size of the closure area may peak about 50 days into the spill and could persist another 2-3 months until the well is killed or capped and the remaining oil is recovered or dissipates. During this period, portions or all of individual State waters would also be closed to commercial fishing.

The economic impacts of closures on commercial fishing are difficult to predict because they are dependent on the season and would vary by fishery. If fishers cannot make up losses throughout the remainder of the season, a substantial part of their annual income would be lost. In some cases, commercial fishers will leave the industry and some may move to areas still open to fishing, but at a greater cost because of longer transit times. Marketing issues are also possible; even if the catch is uncontaminated, the public may lack confidence in the product. The duration of the public's perception of seafood tainting is also difficult to predict and depends to some extent on the duration of the spill and public awareness of the spill.

Phase 3—Onshore Contact

Shoreline contact of oil is estimated to persist from 1 to 5 months in the event of a shallow-water catastrophic spill and for up to 6 months from a deepwater catastrophic spill. The OSRA probability tables show the conditional probabilities (expressed as percent chance) for a shoreline contact for each season, the condition being that a spill is assumed to have occurred at the given location. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

This scenario, depending on the season of occurrence, would cause disruption in commercial fishing activity because many commercial fishermen operate inshore in State waters.

In addition to closures in Federal waters, portions of individual State waters would also be closed to commercial fishing. The economic impacts of closures on commercial fishing are complicated to predict because it is dependent on season and would vary by fishery. If fishers cannot make up losses in the remainder of the season, a substantial part of their annual income will be lost. In some cases, commercial fishers may move to areas still open to fishing, but at a greater cost because of longer transit times and, in some instances, additional license costs. Some commercial fishermen may also augment their income by aiding in the cleanup effort and/or renting the boats as vessels of opportunity.

Phase 4—Post-Spill, Long-Term Recovery and Response

The Gulf of Mexico is an important biological and economic area in terms of commercial seafood production and recreational fishing. Commercial fishermen in the Gulf of Mexico harvested over 1.5 billion pounds of finfish and shellfish in 2010 (USDOC, NMFS, 2012d). The economic impacts of closures on commercial fishing are complicated to predict because the economic effects are dependent on season and would vary by fishery. If fishermen cannot make up losses by fishing the remainder of the season or by participating as contractors in the cleanup, a substantial part of their annual income could be lost and may force them out of the industry. While the commercial fishing industry of Texas did not sustain measurable direct or indirect economic effects following the 1979 *Ixtoc I* blowout and spill (Restrepo et al., 1982), there is a documented phenomenon that, long after an incident, the perception of tainted fish and shellfish from the impacted area persists (Keithly and Diop, 2001). Data regarding the duration of the negative perception of Gulf seafood following the *Deepwater Horizon* explosion, oil spill, and response are not yet available. It is reasonable to assume that a negative perception could impact the value of commercial fish resources for several seasons.

Overall Summary and Conclusion (Phases 1-4)

The Gulf of Mexico is one of the largest producers of seafood in the continental United States. Various commercial species are fished from State waters through the Exclusive Economic Zone and are found throughout the water column. The primary economic impacts of oil spill on commercial fisheries are the closure of State or Federal waters to fishing and the perception of seafood tainting by the market. Both of these factors are difficult to predict. Closures depend on the size, timing, depth of water, and location of the spill as well as the fishery involved. Perception depends on length of the spill and public perception. Both of these factors could affect the livelihood of the fishing community.

B.3.1.19. Recreational Fishing

Phase 1—Initial Phase

About 20 percent of the recreational fishing activity in the Gulf of Mexico occurs within 300 ft (91 m) of oil and gas structures (Hiett and Milon, 2002). Therefore, an explosion and fire could endanger recreational fishermen and divers in the immediate vicinity of the blowout, especially if the blowout is located close to shore. Recreational vessels in the area would likely aid in initial search-and-rescue operations but they would also be in danger during the explosion and subsequent fire. The subsequent fire could burn for up to a month, during which recreational vessels would be expected to avoid the area and to not interfere with response activities. It is also possible that recreational fishing could be impacted in areas beyond the immediate area of the event due to the perceptions of the public.

Phase 2—Offshore Spill

If a catastrophic spill were to occur, a substantial portion of ocean waters could be closed. For example, 88,522 square miles (mi^2) (229,271 square kilometers [km^2]) were closed to recreational fishing activity at the peak of the *Macondo* well oil spill. However, the majority of recreational fishing activity occurs fairly close to shore. Therefore, while the spill remains offshore, the impacts would be particularly felt with respect to fishing of offshore species such as king mackerel and red snapper (the impacts of a catastrophic spill on fish populations are discussed in **Chapter B.3.1.17**). The NOAA's Center for Coastal Monitoring and Assessment (USDOC, NOAA, 2012a) provides a set of maps that display the locations in the Gulf of Mexico where certain fish species are prevalent. However, even while the spill remains offshore, there could be impacts to inshore recreational fishing due to misperceptions regarding the extent of the spill or due to concerns regarding the tainting of fish species. These misperceptions could also reduce tourism activity, which would impact tourism-based recreational fishing activity.

In 2011, the percent of each Gulf Coast State's recreational fishing activity that occurred in State and Federal ocean waters combined (i.e., not inland waters) were as follows: Texas (6%); Louisiana (5%); Mississippi (2%); Alabama (42%); and West Florida (34%) (USDOC, NMFS, 2012e; Texas Parks and Wildlife Department, 2012). **Chapter 4.1.1.20** of this Supplemental EIS provides a further breakdown of recreational fishing activity by state. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Phase 3—Onshore Contact

If a catastrophic spill were to reach shore, there would likely be noticeable impacts to recreational fishing activity. Since most recreational fishing activity occurs fairly close to shore, there would be a number of direct impacts to angler activity due to the fishing closures that would likely arise. This is particularly true since anglers would find it more difficult to find substitute fishing sites in the case of a catastrophic spill. In 2011, the percent of each Gulf State's recreational fishing activity that occurred inland were as follows: Texas (94%); Louisiana (95%); Mississippi (98%); Alabama (58%); and West Florida (66%) (USDOC, NMFS, 2012e; Texas Parks and Wildlife Department, 2012). The impacts to recreational fishing would also depend on the time of year of the spill. In 2011, 31 percent of angler trips in the Gulf occurred between January and April, 41 percent of angler trips occurred between May and August, and 28 percent of angler trips occurred between September and December (USDOC, NMFS, 2012e). In addition, fishing tournaments are often scheduled for the summer months and would be difficult to reschedule in the aftermath of a catastrophic spill. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

There would also be various economic impacts along the recreational fishing supply chain. Gentner Consulting Group (2010) estimates that recreational fishing activity supports $9.8 million in direct expenditures and $23 million in total sales per day in the Gulf of Mexico. There could be further impacts if the fishing closures persisted long enough to affect purchases of boats and other durable fishing equipment. There could also be further impacts if the loss of opportunities for recreational fishing activity exacerbated the fall in tourism activity that would arise due to the spill.

Phase 4—Post-Spill, Long-Term Recovery and Response

The long-term impacts of a catastrophic spill on recreational fishing activity would primarily depend on the extent to which fish populations recover (refer to **Chapter B.3.1.1.17** for more information). However, the longer term impacts of a spill on recreational fishing activity would also depend on the extent to which public perceptions of fish tainting can be assuaged. In addition, the longer-term impacts would depend on the extent to which the various firms that serve the recreational fishing industry would be able to weather the downturn in activity resulting from the spill.

Overall Summary and Conclusion (Phases 1-4)

Recreational fishing activity could be noticeably impacted in the event of a catastrophic spill. This is particularly the case if the spill reached shore or if the spill occurred during peak times and places of recreational fishing activity. The long-term impacts of a catastrophic spill would depend on the extent to which fish populations recover and the length of time it would take to convince the public that it was again safe to fish in the affected areas.

B.3.1.20. Recreational Resources

Phase 1—Initial Event

The most immediate impacts of a catastrophic spill would be on the recreational fishing and recreational diving activity in the vicinity of the blowout. About 20 percent of the recreational fishing activity and 90 percent of the recreational diving activity in the Gulf of Mexico from Alabama to Texas occurs within 300 ft (91 m) of oil and gas structures (Hiett and Milon, 2002). The impacts on recreational fishing and recreational diving would be greater the closer the blowout occurred to shore. The immediate response activities could also impact ocean-based recreational activity. Finally, there could be impacts to tourism activity since a catastrophic spill would likely receive a large amount of media attention.

Phase 2—Offshore Spill

While the spill is still offshore, there could be some ocean-dependent recreation that is affected (e.g., fishing, diving, and boating), as discussed above. In addition, there may be some effects due either to perceived damage to onshore recreational resources that has not yet materialized or to general hesitation on the part of travelers to visit the overall region because of the spill. A Congressional hearing into this matter (U.S. House of Representatives, 2010) provides a broad overview of some of the effects that were felt along the Gulf Coast subsequent to the *Deepwater Horizon* explosion, oil spill, and response. For example, a representative of Pinellas County estimated that this area had lost roughly $70 million in hotel revenue even though beaches in this area did not receive any oil damage. This type of effect could be due to misperceptions about the spill, uncertainty about the future of the spill, or concerns about whether a tourism experience will be affected even if the destination is only within close proximity to a spill.

As previously mentioned, recreational diving is one offshore recreational activity that would be particularly affected by a catastrophic oil spill. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Phase 3—Onshore Contact

A catastrophic spill has the potential to noticeably impact the Gulf Coast recreation and tourism industries. The water-dependent and beach-dependent components of these industries would be particularly vulnerable. Environmental Sensitivity Indexes (ESI's) provide overall measures of the sensitivity of a particular coastline to a potential oil spill. The ESI's rank coastlines from 1 (least sensitive) to 10 (most sensitive). Marshes and swamps are examples of resources that have ESI's of 10 due to the extreme difficulty of removing oil from these areas; marsh and swamp areas are particularly prevalent in Louisiana. The ESI's for beach areas generally range from 3 to 6, depending on the type of sand and the extent to which gravel is mixed into the beach area; beach areas are particularly prevalent in Texas, Mississippi, Alabama, and Florida. The ESI maps for any coastline along the Gulf of Mexico can be viewed using the National Oceanic and Atmospheric Administration's ERMA mapping system (USDOC, NOAA, 2012b). The ESI maps also provide point indicators for recreational resources.

A catastrophic spill would also raise a number of issues regarding recreational activity that is based on tourism. One important point is that a spill of the *Deepwater Horizon*'s dimensions can influence a much broader range of individuals and firms than can a smaller spill. For example, a small, localized spill may lead some travelers to seek substitute recreational opportunities in nearby areas. However, a large spill is more likely to dissuade travelers from visiting a broader economic region. Similarly, small- and mid-sized restaurant chains and hotels may be able to find other customers or to simply weather a smaller spill. However, a spill the size of the *Deepwater Horizon* is more likely to affect these types of firms since they are less able to diversify their customer base. These effects can be seen in the makeup of those who filed damage claims with BP (Gulf Coast Claims Facility, 2012); the Gulf Coast Claims Facility closed in early 2012 subsequent to preliminary court approval of a settlement program. For example, the bulk of the claims by individuals have been made in the food, beverage, and lodging sector and in the retail, sales, and service sector. Claims have also been made by individuals and firms in a broad range of geographic regions, many of which were not directly impacted by oil.

Murtaugh (2010) provides data on the change in hotel and sales tax receipts for individual Gulf Coast counties in the months immediately following the *Deepwater Horizon* explosion, oil spill, and response. During the summer of 2010, the spill caused substantial declines in hotel receipts in the following counties: Baldwin, Alabama (33.2% decline); Santa Rosa, Florida (24.8% decline); Okaloosa, Florida (24.1% decline); Walton, Florida (12.3% decline); and Bay, Florida (7.4% decline). However, coastal counties west of Baldwin, Alabama (as far west as St. Mary, Louisiana), generally experienced noticeable increases in hotel receipts. This was particularly true in Mobile, Alabama; Jackson, Mississippi; and in the coastal parishes of Louisiana. For example, in Louisiana, St. Mary, Terrebonne, and Lafourche Parishes each reported increases in hotel tax receipts of over 80 percent in the summer of 2010. These effects are likely due to the influx of oil-spill relief workers to these areas in the immediate aftermath of the *Deepwater Horizon* explosion, oil spill, and response. Overall sales tax receipts in counties from Baldwin, Alabama, eastward also generally fell during 2010, although to a lesser extent than hotel tax receipts. Sales tax receipts in counties and parishes west of Baldwin, Alabama, did not show as clear a pattern as did hotel tax receipts. For example, overall sales tax receipts fell by 12.5 percent in Hancock County (Mississippi), receipts were almost unchanged in Harrison County (Mississippi), and receipts increased by 8.3 percent in Orleans Parish (Louisiana). These results suggest that the impacts of a future catastrophic spill will be influenced by the structure of a particular county/parish's recreational economy, as well as by the extent to which oil-spill-response activities will mitigate some of the negative impacts of the spill in certain areas.

There could also be effects on tourist activities in areas far away from the areas directly affected by oil. For example, in Texas subsequent to the *Deepwater Horizon* explosion, oil spill, and response, some tourists may have stayed away from Texas Gulf Coast beaches due to misperceptions regarding the extent to which these beaches were damaged due to the spill. Conversely, there may have been some substitution of beach visitation away from beaches in the eastern Gulf towards the beaches in Texas, which were farther from the spill. While it is difficult to quantify these effects, some anecdotal evidence regarding this substitution effect can be found in Pack (2010). Hotel occupancy data suggest that these two effects may have largely offset each other. Source Strategies Inc. (2010) reports that total hotel occupancy in the three metro regions in Texas closest to the Gulf Coast increased just 1.9 percent during the third quarter of 2010 compared with the third quarter of 2009. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

Phase 4—Post-Spill, Long-Term Recovery and Response

The longer-term implications of a catastrophic event on tourism would depend on the extent to which any structural/ecological damage can be repaired and the extent to which economic mitigation actions would occur. The long-term implications of a catastrophic spill would also depend on the extent to which public confidence in the various components of the recreational and tourism economies can be restored. For example, restaurants in the region would be impacted to the extent to which they are perceived to use seafood products caught or raised in contaminated waters. Similarly, although beaches can be decontaminated not long after a spill has been stopped, lingering perceptions can be expected to negatively impact tourism even after a spill has ended.

Oxford Economics (2010) attempts to quantify these effects by analyzing the impacts of recent catastrophic events on recreational economies. For example, they analyzed the *Ixtoc I* well blowout and spill of 1979, the scale and nature of which was reasonably similar to the *Macondo* well blowout and spill of 2010. In this example, it took approximately 3 years for beaches to be cleaned and for recreational activity to return to similar levels as before the spill. They also looked at the *Prestige* oil spill of 2002 off the coast of Spain. Given the nature and size of that spill, recreational activity was able to return to pre-spill levels in approximately 1 year. Alaska's tourism economy took approximately 2 years to recover from the *Exxon Valdez* spill.

Overall Summary and Conclusion (Phases 1-4)

A catastrophic spill can cause noticeable impacts to recreational resources such as beaches. A catastrophic spill can also have complex effects on recreational activity that depends on tourism. The longer-term implications of a catastrophic oil spill on tourism would depend on the extent to which any structural/ecological damage can be repaired, the extent to which economic mitigation actions would occur, and the speed at which public confidence in the various components of the affected recreational and tourism economies would be restored.

B.3.1.21. Archaeological Resources

Phase 1—Initial Event

Offshore Archaeological Resources

BOEM protects all known, discovered, and potentially historic and prehistoric archaeological resources on the OCS by requiring appropriate avoidance criteria as well as directives to investigate these resources. Onshore archaeological resources, prehistoric and historic sites, would not be immediately impacted during the initial phase of a catastrophic blowout because the distance of a blowout site from shore is at least 3 nmi (3.5 mi; 5.6 km). However, offshore catastrophic blowouts, when compared with spills of lesser magnitude, may initially impact multiple archaeological resources. Resources adjacent to a catastrophic blowout could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during emergency relief well drilling, or contaminated by the hydrocarbons.

Based on historical information, over 2,100 potential shipwreck locations have been identified on the Gulf of Mexico OCS (USDOI, MMS, 2007). This number is a conservative estimate and is heavily weighted toward post-19th century, nearshore shipwrecks, where historic records documenting the loss of the vessels were generated more consistently. Of the 2,100 recorded wrecks, only 233 records were determined to have associated spatial data possessing sufficient accuracy for BOEM's needs.

In certain circumstances, BOEM's Regional Director may require the preparation of an archaeological report to accompany the exploration plan, development operations coordination document, or development and production plan, under 30 CFR § 550.194, and BSEE's Regional Director may do likewise under 30 CFR § 250.194 if a potential wreck is encountered during operations. As part of the environmental reviews conducted for postlease activities, available information will be evaluated regarding the potential presence of archaeological resources within a CPA proposed action area to determine if additional archaeological resource surveys and mitigations are warranted. Having complete knowledge of seafloor resources before a spill occurs would enable responders to quickly plan countermeasures in a way that would minimize adverse effects occurring from the spill response.

Phase 2—Offshore Spill

Offshore Archaeological Resources

Due to the response methods (i.e., subsea dispersants) and magnitude of the response (i.e., thousands of vessels), a catastrophic blowout and spill have a greater potential to impact offshore archaeological resources than other accidental events.

Deep Water

In contrast to smaller spills or spills in shallow water, large quantities of subsea dispersants could be used for a catastrophic subsea blowout in deep water. This could result in currently unknown effects from dispersed oil droplets settling to the seafloor. Though information on the actual impacts to submerged cultural resources is inconclusive at this time, oil settling to the seafloor could come in contact with archaeological resources. At present, there is no evidence of this having occurred. A recent experimental study has suggested that, while the degradation of wood in terrestrial environments is initially retarded by contamination with crude oil, at later stages, the biodeterioration of wood was accelerated (Ejechi, 2003). While there are different environmental constraints that affect the degradation of wood in terrestrial and waterlogged environments, soft-rot fungal activity, one of the primary wood degrading organisms in submerged environments, was shown to be increased in the presence of crude oil. There is a possibility that oil from a catastrophic blowout could come in contact with wooden shipwrecks and artifacts on the seafloor and accelerate their deterioration.

Ancillary damages from vessels associated with oil-spill-response activities (e.g., anchoring) in deep water are unlikely because of the use of dynamically positioned vessels responding to a deepwater blowout. If response and support vessels were to anchor near a deepwater blowout site, the potential to damage undiscovered vessels in the area would be high because of the required number and the size of anchors and the length of mooring chains needed to safely secure vessels. Additionally, multiple offshore vessel decontamination stations would likely be established in shallow water outside of ports or entrances to inland waterways, as seen for the *Deepwater Horizon* explosion, oil spill, and response. The anchoring of vessels could result in damage to both known and undiscovered archaeological sites; the potential to impact archaeological resources increases as the density of anchoring activities in these areas increases.

Shallow Water

The potential for damaging archaeological resources increases as the oil spill and related response activities progress landward. In shallower waters, most of the damage would be associated with oil cleanup and response activities. Thousands of vessels would respond to a shallow-water blowout and would likely anchor, potentially damaging both known and undiscovered archaeological sites. Additional anchoring would be associated with offshore vessel decontamination stations, as described above. As the spill moves into the intertidal zone, the chance of direct contact between the oil and archaeological resources increases. As discussed above, this could result in increased degradation of wooden shipwrecks and artifacts.

Additionally, in shallower waters, shipwrecks often act as a substrate to corals and other organisms, becoming an essential component of the marine ecosystem. These organisms often form a protective layer over the shipwreck, virtually encasing the artifacts and hull remains. If these fragile ecosystems were destroyed as a result of the oil spill and the protective layer was removed, the shipwreck would then be exposed to increased degradation until it reaches a new level of stasis with its surroundings.

Regardless of water depth, because oil is a hydrocarbon, heavy oiling could contaminate organic materials associated with archaeological sites, resulting in erroneous dates from standard radiometric dating techniques (e.g., ^{14}C-dating). Interference with the accuracy of ^{14}C-dating would result in the loss of valuable data necessary to understand and interpret the sites.

Phase 3—Onshore Contact

Onshore Archaeological Resources

Regardless of the water depth in which the catastrophic blowout occurs, it is assumed that more than 1,000 mi (1,609 km) of shoreline could be oiled to some degree. Onshore prehistoric and historic sites would be impacted to some extent by a high-volume spill from a catastrophic blowout that reaches shore. According to Louisiana State Archaeologist Charles McGimsey, sites on barrier islands could suffer the heaviest impact. A few prehistoric sites in Louisiana, located inland from the coastline in the marsh and along bayous, could experience some light oiling. As discussed above, impacts would include the loss of ability to accurately date organic material from archaeological sites because of contamination or increased research costs to clean samples for analysis. Efforts to prevent coastal cultural resources from becoming contaminated by oil would likely be overwhelmed in the event of a hurricane and by the magnitude of shoreline impacted. The most significant damage to archaeological sites could be related to cleanup and response efforts. Fortunately, important lessons were learned from the *Exxon Valdez* spill in Alaska in 1989, in which the greatest damage to archaeological sites was related to cleanup activities and looting by cleanup crews rather than from the oil itself (Bittner, 1996). As a result, cultural resources were recognized as significant early in the response, and archaeologists are, at present, embedded in Shoreline Cleanup Assessment Teams (SCAT) and are consulting with cleanup crews. Historic preservation representatives are present at both the Joint Incident Command as well as each Area Command under the general oversight of the National Park Service to coordinate response efforts (Odess, official communication, 2010). Despite these efforts, some archaeological sites suffered damage from looting or from spill cleanup activities (most notably the parade ground at Fort Morgan, Alabama) (Odess, official communication, 2011).

Phase 4—Post-Spill, Long-Term Recovery and Response

Onshore Archaeological Resources

Regardless of the water depth in which the catastrophic blowout occurs, it is assumed that more than 1,000 mi (1,609 km) of shoreline could be oiled to some degree. Onshore prehistoric and historic sites would be impacted to some extent by a high-volume spill from a catastrophic blowout that reaches shore. A few prehistoric sites in Louisiana, located inland from the coastline in the marsh and along bayous, could experience some light oiling. As discussed above, impacts would include the permanent loss of ability to accurately date organic material from archaeological sites because of contamination. As discussed above, the most significant damage to archaeological sites could be related to cleanup and response efforts. Long-term recovery would prove difficult if not impossible. Historic structures such as coastal forts that are exposed to oiling are generally constructed of brick or other porous, friable materials that are difficult to clean without causing further damage (Chin and Church, 2010). Funding for any sort or archaeological recovery is problematic outside of Federal lands because of existing laws and regulations. Most coastal prehistoric sites in Louisiana, for example, are on private lands where there is no mechanism to recover damages. Section 106 of the National Historic Preservation Act is triggered by a Federal action, which in the case of a spill, would be the response and not the actual spill. The Natural Resource Damage Assessment (NRDA) process codified by the Oil Pollution Act of 1990 is a legal process to determine the type and amount of restoration needed to compensate the public for harm to natural resources that occurs as a result of an oil spill, but it does not cover cultural, archaeological, or historic properties.

Overall Summary and Conclusion (Phases 1-4)

Archaeological resources are finite, unique, irreplaceable, nonrenewable records of mankind’s past, which, once destroyed or damaged, are gone forever. In the event of a catastrophic oil spill, the most likely source of irreversible impact is, ironically, from the spill response itself, and the danger increases dramatically as the response approaches the shoreline. This damage can, to a large extent, be mitigated by the early integration of archaeologists and State and Tribal historic preservation officers in the response to protect sites from impact. Mitigation of impacts from the oil itself are likely to meet with varied success depending upon the type of site and availability of funding.

B.3.1.22. Land Use and Coastal Infrastructure

Phase 1—Initial Event

There would likely be no adverse impacts to land use and coastal infrastructure as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because of the long distance (>3 nmi; 3.5 mi; 5.6 km) from shore and the short duration of the initial event, fire, and/or explosion..

Phase 2—Offshore Spill

Impacts to tourism and recreational resources are addressed in **Chapter B.3.1.20**. Possible fisheries closures are addressed in **Chapters B.3.1.18 and B.3.1.19**. As cleanup and remediation efforts evolve, there would be increased activity at ports and coastal cities, leading to increased traffic on road infrastructure and at port facilities. This follows from consideration of BOEM's scenario estimates of up to 3,000 vessels, 25-50 planes/helicopters, and up to 25,000 workers for a shallow-water event and up to 7,000 vessels, 50-100 planes/helicopters, and up to 50,000 workers for a deepwater event. Waste disposal activities associated with boom deployment and retrieval would increase demand at waste disposal facilities. BOEM's scenario estimates 5 million feet (1.5 million meters) of boom deployment and 35,000 bbl of dispersant applied at the surface for a shallow-water event or 11 million feet (3.4 million meter) of boom deployment and 33,000 bbl of dispersant applied at the surface and 16,500 bbl of dispersant applied subsea for a deepwater event. Also, vessel decontamination sites would be set up offshore and the staffing/maintenance of these sites would contribute to increased activity at port facilities and traffic congestion on coastal waterways and highways.

Phase 3—Onshore Contact

In the event of a catastrophic spill, impacts on land use and infrastructure would be temporary and variable in nature. The scale of impact would depend on the nature of the event and whether it occurs in shallow or deep water. These impacts would include land use in staging areas, waste disposal locations and capacities, and potential delays because of vessel decontamination stations near ports, as described below.

For a shallow-water event, BOEM estimates 5-10 staging areas and 200-300 skimmers. For a deepwater event, scenario estimates call for 10-20 staging areas and 500-600 skimmers. Given these estimates and the several thousand responders that would be involved in the effort, BOEM expects a further increase in traffic congestion and some possible competing land-use issues near the staging areas, depending on the real estate market at the time of the event. Some infrastructure categories, such as vessels, ports, docks and wharves, would likely become very engaged in response activities and this could result in a shortage of space and functionality at infrastructure facilities if ongoing drilling activities were simultaneously occurring. However, if drilling were to be suspended, conflicting demands on infrastructure facilities would likely fail to materialize.

In the category of waste disposal, the impacts would be more visible as thousands of tons of oily liquid and solid wastes from the oil-spill cleanup would be disposed of in onshore landfills. As was the case in the *Deepwater Horizon* explosion, oil spill, and response, USEPA, in consultation with USCG, would likely issue solid-waste management directives to address the issue of contaminated materials and solid or liquid wastes that are recovered as a result of cleanup operations (USEPA, 2010c and 2010d).

For navigation and port use, there would also be the potential for delays in cargo handling and slow vessel traffic because of decontamination operations at various sites along the marine transportation system (USDOT, 2010). However, vessel decontamination activities most likely would be complete within a year of the event, so impacts would be expected to be limited in duration.

Phase 4—Post-Spill, Long-Term Recovery and Response

Based on the rapid recovery of infrastructure that was heavily damaged by the catastrophic 2005 hurricane season and the region's experience in the few years since the *Deepwater Horizon* explosion, oil spill, and response, BOEM would not expect any long-term impacts to land use and coastal infrastructure as a result of a catastrophic oil-spill event. However, if a catastrophic oil spill were to occur, BOEM would (as it is currently with regard to the *Deepwater Horizon* explosion, oil spill, and response) monitor the post-spill, long-term recovery phase of the event for any changes that indicate otherwise. A catastrophic spill could generate several thousand tons of oil-impacted solid materials disposed in landfills along the Gulf Coast. This waste may contain debris, beach, or marsh material (sand/silt/clay), vegetation, and personal protection equipment collected during cleanup activities. BOEM does not expect that landfill capacity would be an issue at any phase of the oil-spill event or the long-term recovery. In the case of the *Deepwater Horizon* explosion, oil spill, and response, USEPA reported that existing landfills receiving oil-spill waste had plenty of capacity to handle waste volumes; the *Deepwater Horizon* explosion, oil spill, and response's waste that was disposed of in landfills represented less than 7 percent of the total daily waste normally accepted at these landfills (USEPA, 2012).

It is not expected that any long-term, land-use impacts would arise from properties that are utilized for restoration activities and would somehow have their future economic use compromised. The rise or fall of property values would not be solely a function of some kind of economic impact from a catastrophic oil-spill event. There are many other factors that influence the value of property and its best economic use. To date, it is not clear from past experiences whether vegetation loss or erosion created by a spill could result in changes in land use. The amount and location of erosion and vegetation loss could be influenced by the time of year the spill occurs, its location, and weather patterns, including hurricane landfalls.

Overall Summary and Conclusion (Phases 1-4)

There would likely be no adverse impacts to land use and coastal infrastructure throughout Phase 1 of a catastrophic spill event. Response efforts in Phases 2 and 3 would require considerable mobilization of equipment and people. While these efforts might temporarily displace traditional users of coastal land and infrastructure, these interruptions would not be long lasting. The post-spill, long-term recovery and response efforts during Phase 4 could generate several thousand tons of oil-impacted solid materials disposed in landfills along the Gulf Coast, but this would account for no more than 7 percent of the total daily waste normally accepted in these landfills. It is also not expected that any properties utilized for restoration activities throughout Phase 3 would not suffer any long-term land use or economic impacts.

B.3.1.23. Demographics

Phase 1—Initial Event

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). Since the impacts of a catastrophic spill on employment would take time to evolve, the initial impacts on demographics would be minimal. Therefore, there would likely be no adverse impacts to demographics as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event.

Phase 2—Offshore Spill

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). For example, there could be some suspension of oil/gas activities in the immediate aftermath of the spill. This could cause some workers to seek employment outside of the OCS industry, for example in onshore oil/gas extraction or on overseas offshore projects. However, since the OCS oil and gas industry would likely eventually recover, the long-term impacts on demographics would be small. There could also be impacts on demographics if employment in recreation, tourism, or fishing industries were affected, due to either actual or perceived impacts of the spill. However, the impacts on these industries would become more acute if the spill were to reach shore.

Phase 3—Onshore Contact

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). For example, impacts to recreation/tourism and recreational and commercial fishing activities would become more acute if the spill were to reach shore. There would also be a larger presence of cleanup workers in some areas if the spill were to reach shore. For example, 48,200 workers were employed in response activities at the peak of the response effort following the *Macondo* well blowout and spill (RestoreTheGulf.gov, 2011). However, these impacts would be temporary and would be governed by the dynamics of the particular spill. There could also be impacts to demographics if there were impacts on the response workers' health or if the demographics of the response workers were noticeably different from the local population.

Phase 4—Post-Spill, Long-Term Recovery and Response

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). The spill's impacts on employment, and therefore demographics, would primarily be felt in the oil/gas, recreational fishing, commercial fishing, and recreation/tourism industries. However, it is unlikely that a catastrophic spill would cause substantial long-term changes to a region's demographics. For example, the demographics data in Woods and Poole Economics, Inc. (2011) did not suggest large demographic changes to any Gulf regions subsequent to the *Deepwater Horizon* explosion, oil spill, and response.

Overall Summary and Conclusion (Phases 1-4)

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). These impacts would likely be temporary and would be governed by the particular dynamics of the spill.

B.3.1.24. Economic Factors

Phase 1—Initial Event

The most immediate economic impacts of a catastrophic spill would be on the oil/gas production and employment associated with the area of the spill. There could also be impacts on commercial fishing (**Chapter B.3.1.18**), recreational fishing (**Chapter B.3.1.19**), and recreational resources (**Chapter B.3.1.20**). However, the primary economic impacts of a catastrophic spill would depend how the spill evolves, which is discussed in subsequent sections.

Phase 2—Offshore Spill

In contrast to a less severe accidental event, suspension of some oil and gas activities would be likely following a catastrophic event. Depending on the duration and magnitude, this could impact hundreds of oil-service companies that supply the steel tubing, engineering services, drilling crews, and marine supply boats critical to offshore exploration. An interagency economic report estimated that the suspension arising from the *Deepwater Horizon* explosion, oil spill, and response may have directly and indirectly resulted in up to 8,000-12,000 fewer jobs along the Gulf Coast (USDOC, Economics and Statistics Administration, 2010). Greater New Orleans Inc. (2012) provides an overview of the impacts of decreased oil and gas industry operations subsequent to the *Deepwater Horizon* explosion, oil spill, and response. This report provides survey evidence regarding the various economic strains felt by businesses in Louisiana due to the *Deepwater Horizon* explosion, oil spill, and response. For example, this report found that 41 percent of the respondents were not making a profit due to the slowdown in operations. The economic impacts of a catastrophic spill would likely be more heavily concentrated in smaller businesses than in the larger companies due to their difficulty in finding substitute revenue sources. Much of the employment loss would be concentrated in coastal oil-service parishes in Louisiana (St. Mary, Terrebonne, Lafourche, Iberia, and Plaquemines Parishes) and counties/parishes where drilling-related employment is most concentrated (Harris County, Texas, in which Houston is located, and Lafayette Parish, Louisiana). There could also be economic impacts due to the impacts on commercial fishing (**Chapter B.3.1.18**), recreational fishing (**Chapter B.3.1.19**), and recreational resources (**Chapter B.3.1.20**).

Phase 3—Onshore Contact

By the end of a catastrophic spill, a large number of personnel (up to 25,000 in the event of a shallow-water spill and up to 50,000 in the event of a deepwater spill) would be expected to have responded to protect the shoreline and wildlife and to cleanup vital coastlines. The degree to which new cleanup jobs offset job losses would vary greatly from county to county (or parish to parish). However, these new jobs would not make up for lost jobs, in terms of dollar revenue. In most cases, cleanup personnel are paid less (e.g., $15-$18 per hour compared with roughly $45 per hour on a drilling rig), resulting in consumers in the region having reduced incomes overall and thus, spending less money in the economy (Aversa, 2010). In addition, the economic impacts of relief workers would likely vary by county or parish, causing noticeable positive economic impacts to some counties or parishes while having fairly small positive impacts in other counties or parishes (Murtaugh, 2010). However, the influx of relief workers could also cause some negative impacts if it disrupted some of the normal functioning of economies. In addition, if the spill reaches shore, the impacts to commercial fishing (**Chapter B.3.1.18**), recreational fishing (**Chapter B.3.1.19**), and recreational resources (**Chapter B.3.1.20**) would likely be greater.

In the unfortunate event of a future disaster, the creation of a large financial claims administration process, similar to the Gulf Coast Claims Facility, would be likely. This administrative body would be responsible for distributing funds made available by the responsible party to parties financially hurt by the disaster. As demonstrated by the actions of Gulf Coast Claims Facility recipients following the *Deepwater Horizon* explosion, oil spill, and response, funds will likely be used by individuals to pay for necessities such as mortgages or groceries, while businesses who receive funds will likely use them to maintain payroll and current payments on equipment. As of March 2012, over $6 billion had been paid through the Gulf Coast Claims Facility, which mitigated some of the economic impacts of the *Deepwater Horizon* explosion, oil spill, and response (Gulf Coast Claims Facility, 2012).

Phase 4—Post-Spill, Long-Term Recovery and Response

While a catastrophic spill could immediately impact several Gulf Coast States for several months through fishing closures, loss of tourism, and any suspension of oil and gas activities, anticipating the long-term economic and employment impacts in the Gulf of Mexico is a difficult task. Many of the potentially affected jobs, like fishing charters, are self-employed. Thus, they would not necessarily file for unemployment and will not be included in business establishment surveys used to estimate State unemployment levels. In addition, unemployment numbers in states are based on nonagricultural jobs, and the fishing industry is considered within the agriculture category. On the other side, it is also a challenge to estimate how many of these displaced workers have been hired to clean up the spill. For example, while thousands of vessels of opportunity would be active in the spill response, not all of these would be displaced commercial fishermen from the affected areas. The positive employment impacts related to response activities are likely to be shorter term than the negative impacts discussed above. However, the long-term economic impacts of a catastrophic spill will likely depend on the speed at which the oil/gas, commercial fishing, recreational fishing, and recreational industries recover.

Overall Summary and Conclusion (Phases 1-4)

There would be a number of economic impacts that would arise from a catastrophic oil spill. The most direct effects would be on the recreation/tourism, commercial fishing, and recreational fishing industries that depend on damaged resources. There could also be substantial negative effects on the oil/gas industry due to moratoriums or rule changes that would arise. Finally, there could be substantial impacts due to the relief operations and economic mitigation activities that would occur in the aftermath of a catastrophic spill.

B.3.1.25. Environmental Justice

Phase 1—Initial Event

There would likely be no adverse impacts to environmental justice as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because of the long distance (>3 nmi; 3.5 mi; 5.6 km) from shore and the short duration of the initial event, fire, and/or explosion.

Phase 2—Offshore Spill

The environmental justice policy, based on Executive Order 12898 of February 11, 1994, directs agencies to incorporate into NEPA documents an analysis of potentially disproportionate and detrimental environmental and health effects of their proposed actions on minorities and low-income populations and communities. While the spill is still offshore, the primary environmental justice concern would be large commercial fishing closures disproportionately impacting minority fishers. In the event of a catastrophic spill, Federal and State agencies would be expected to close substantial portions of the Gulf to commercial and recreational fishing (USDOC, NOAA, 2010e). While oystering occurs "onshore," oyster beds are also likely to be closed to harvests during Phase 2 of a catastrophic spill because of concerns about oil contamination and increased freshwater diversions to mitigate oil intrusion into the marshes. These closures would directly impact commercial fishermen and oystermen, and indirectly impact such downstream activities as shrimp processing facilities and oyster shucking houses. The mostly African-American communities of Phoenix, Davant, and Point a la Hache in Plaquemines Parish, Louisiana, are home to families with some of the few black-owned oyster leases. Just as these leases have been threatened by freshwater diversion projects for coastal restoration, they could be threatened by Phase 2 of a catastrophic spill (Mock, 2010).

The Gulf of Mexico coast hosts multiple minority and low-income groups whose use of natural resources of the offshore and coastal environments make them vulnerable to fishing closures. While not intended as an inventory of the area's diversity, we have identified several Gulf of Mexico coast populations of particular concern. An estimated 20,000 Vietnamese American fishermen and shrimpers live along the Gulf of Mexico coast; by 1990, over 1 in 20 Louisiana fishers and shrimpers had roots in Southeast Asia even though they comprised less than half a percent of the State's workforce (Bankston and Zhou, 1996). Vietnamese Americans account for about one-third of all the fishermen in the central Gulf of Mexico (Ravitz, 2010). Islaños, African Americans, and Native American groups are also engaged in commercial fishing and oystering. Historically, Vietnamese Americans and African Americans have worked in the fish processing and oyster shucking industries. Shucking houses particularly, have provided an avenue into the mainstream economy for minority groups.

Therefore, fishing closures during Phase 2 of a catastrophic spill impacting the central Gulf of Mexico may disproportionately affect such minority groups as the Vietnamese Americans, Native Americans, African Americans, and Islaños (Hemmerling and Colten, 2003).

Phase 3—Onshore Contact

While most coastal populations along the Gulf of Mexico coast are not generally minority or low income, several communities on the coasts of St. Mary, Lafourche, Terrebonne, St. Bernard, and Plaquemines Parishes, Louisiana, have minority or low-income population percentages that are higher than their state average. These minority populations are predominately Native American, Islaños, or African American. For example, a few counties or parishes along the Gulf Coast have more than a 2-percent Native American population (USDOI, MMS, 2007); about 2,250 Houma Indians (a State of Louisiana recognized tribe) are concentrated in Lafourche Parish, Louisiana, comprising 2.4 percent of the parish's population, and about 800 Chitimacha (a federally recognized tribe) make up 1.6 percent of St. Mary Parish's population. While these are not significant numbers on their own, viewed in the context of Louisiana's overall 0.6 percent Native American average, these communities take on greater environmental justice importance.

Gulf Coast minority and low-income groups are particularly vulnerable to the coastal impacts of a catastrophic oil spill due to their greater than average dependence on the natural resources in the offshore and coastal environments. Besides their economic reliance on commercial fishing and oystering, coastal low-income and minority groups rely heavily on these fisheries and other traditional subsistence fishing, hunting, trapping, and gathering activities to augment their diets and household incomes (refer to Hemmerling and Colton, 2003, for an evaluation of environmental justice considerations for south Lafourche Parish). Regular commuting has continued this reliance on the natural resources of the coastal environments even when populations have been forced to relocate because of landloss and the destruction from hurricane events.

State fishery closures because of a catastrophic oil spill could disproportionately affect minority and low-income groups. Shoreline impacts could generate additional subsistence-related effects. Therefore, these minority groups may be disproportionately affected if these coastal areas were impacted by a catastrophic spill and the resulting response.

Phase 4—Post-Spill, Long-Term Recovery and Response

After the spill is stopped, the primary environmental justice concerns relate to possible long-term health impacts to cleanup workers, a predominately minority population, and to possible disposal of oil-impacted solid waste in predominantly minority areas.

An analysis of socioeconomic characteristics shows that people of Cajun ethnicity in the Gulf Coast States are often found to be of a comparatively low socioeconomic status and to work jobs in the textile and oil industries (Henry and Bankston, 1999). Past studies suggest that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations (Tolbert, 1995). One BOEM-funded study in Louisiana found income inequality decreased during the oil boom of the 1980's and increased with the decline (Tolbert, 1995). If there is a suspension of oil and gas activities in response to a catastrophic spill, many oil- and gas-related service industries would attempt to avoid massive layoffs by cutting costs and deferring maintenance during the recovery. This was the case with the *Deepwater Horizon* explosion, oil spill, and response, and the long-term impacts are still not fully understood.

Onshore and Offshore Cleanup Workers

By the end of a catastrophic spill, up to 25,000 (shallow water) or 50,000 (deepwater) personnel would be expected to be responding to the spill. The majority of these would be field responders (United Incident Command, 2010e). As seen by the *Deepwater Horizon* explosion, oil spill, and response, the racial composition of cleanup crews was so conspicuous that Ben Jealous, the president of the National Association for the Advancement of Colored People, sent a public letter to BP Chief Operations Officer Tony Hayward on July 9, 2010, demanding to know why African Americans were over-represented in "the most physically difficult, lowest paying jobs, with the most significant exposure to toxins" (National Association for the Advancement of Colored People, 2010). While regulations require the wearing of protective gear and only a small percentage of cleanup workers suffer immediate illness and injuries (Center for Disease Control and Prevention, 2010), exposure could have long-term health impacts (e.g., increased rates of some types of cancer) (Savitz and Engel, 2010; Kirkeleit et al., 2008). Aguilera et al. (2010) compiled and reviewed existing studies on the repercussions of spilled oil exposure on human health for patterns of health effects and found evidence of the relationship between exposure and "acute physical, psychological, genotoxic, and endocrine effects in the exposed individuals." Acute symptoms from exposure to oil, dispersants, and degreasers include headaches, nausea, vomiting, diarrhea, sore eyes, runny nose, sore throat, cough, nose bleeds, rash, blisters, shortness of breath, and dizziness (Sathiakumar, 2010). The USEPA's monitoring data have not shown that the use of dispersants during the *Deepwater Horizon* explosion, oil spill, and response resulted in a presence of chemicals that surpassed human health benchmarks (Trapido, 2010). The potential for the long-term human health effects are largely unknown. However, the National Institute of Environmental Health Sciences is conducting a study known as the "Gulf Long-Term Follow-Up Study" that should provide a better understanding of the long-term and cumulative health impacts, such as the consequences of working close to a spill and of consuming contaminated seafood. The "Gulf Long-Term Follow-up Study" will monitor oil-spill cleanup workers for 10 years and represents a national effort to determine if the Gulf oil spill led to physical or mental health problems (U.S. Dept. of Health and Human Services, NIEHS, 2010). The study has a target goal of 55,000 participants. As of October 2012, the National Institute of Environmental Health Sciences announced that over 29,000 cleanup workers and volunteers have enrolled in the "Gulf Long-Term Follow-up Study" (U.S. Dept. of Health and Human Services, NIEHS, 2012). Prior research on post-spill cleanup efforts found that the duration of cleaning work was a risk factor for acute toxic symptoms and that seamen had the highest occurrence of toxic symptoms compared with volunteers or paid workers. Therefore, participants in the "Vessels of Opportunity" program, which recruited local boat owners (including Cajun, Houma Indian, and Vietnamese American fishermen) to assist in cleanup efforts, would likely be one of the most exposed groups. African Americans are thought to have made up a high percentage of the cleanup workforce. The Occupational Safety and Health Administration (OSHA) released two matrices of gear requirements for onshore and offshore Gulf operations that were organized by task (U.S. Dept. of Labor, OSHA, 2010a). Of past oil-spill workers, uninformed and poorly informed workers were at more risk of exposure and symptoms, demonstrating the importance of education and proper training of workers (Sathiakumar, 2010). Therefore, a catastrophic spill may disproportionately affect seamen and onshore workers such as Cajuns, Vietnamese Americans, Houma Indian, and African Americans.

Solid-Waste Disposal

Following a catastrophic spill, environmental justice concerns arise related to the disposal of cleanup-related wastes near minority and/or low-income communities (Schleifstein, 2010). It is estimated that a catastrophic spill could generate several thousand tons of oil-impacted solid materials that would be disposed in landfills along the Gulf Coast. While no new landfills would be built because of a catastrophic spill, the use of existing landfills might exacerbate existing environmental justice issues. For example, Mobile, Alabama, and Miami, Florida, are majority minority urban centers with a majority of minority residents living within a 1-mi (1.6-km) radius of chosen landfills or liquid processing centers. While only a small percentage of *Deepwater Horizon* explosion, oil spill, and response waste was sent to these facilities—13 percent of the liquid waste to Liquid Environmental Solutions in Mobile and only 0.28 percent of the total liquid waste to Cliff Berry in Miami—they may receive more from potential future spills. Disposal procedures for the *Deepwater Horizon* explosion, oil spill, and response involved sorting waste materials into standard "waste stream types" at small, temporary stations, and then sending each type to existing facilities that were licensed to dispose of them. The location of temporary sorting stations was linked to the location of containment and cleanup operations. Hence, future locations of any sorting stations are not predictable since they would be determined by the needs of cleanup operations. However, waste disposal locations were determined by the specializations of existing facilities and by contractual relationships between them and the cleanup and containment firms. Louisiana received about 82 percent of the *Deepwater Horizon* explosion, oil spill, and response liquid waste recovered; of this, 56 percent was manifested to mud facilities located in Venice in Plaquemines Parish, Louisiana, and to Port Fourchon in Lafourche Parish, Louisiana, and then transferred to a processing facility in Port Arthur, Texas. The waste remaining after processing was sent to deep well injection landfills located in Fannett and Big Hill, Texas. The sites located in Venice and Port Fourchon, Louisiana, and in Port Arthur, Fannett, and Big Hill, Texas, have low-minority populations, but a few of these areas have substantial poverty rates relative to State and parish/county means.

Overall Summary and Conclusion (Phases 1-4)

For Phase 1 (Initial Event) of a catastrophic spill, there would likely be no adverse impacts to minority and low-income communities because of the long distance (>3 nmi; 3.5 mi; 5.6 km) from shore, as well as the short duration of the initial event, fire, and/or explosion. The primary environmental justice concerns during Phase 2 (Offshore Spill) would be large-scale fishing closures, oyster bed contamination and closures, and subsequent impacts to downstream activities such as shrimp processing facilities and oyster shucking houses. These may disproportionately affect such minority groups as the Vietnamese Americans, Native Americans, African Americans, and Islaños. Phase 3 (Onshore Contact), depending on the location, could result in disproportional impacts to those groups that rely heavily on oystering, commercial fishing, and other traditional subsistence fishing, hunting, trapping, and gathering activities to augment their diets and household incomes. During Phase 4 (Post-Spill, Long-Term Recovery and Response), the primary environmental justice concerns relate to possible long-term health impacts to cleanup workers, a predominately minority population, and to the possible disposal of oil-impacted solid waste in predominantly minority areas. As in the case of the *Deepwater Horizon* explosion, oil spill, and response, understanding long-term impacts would be dependent on the outcome of ongoing research by various interested parties, such as the National Institutes of Health and BOEM. Overall, depending on a number of mainly geographic variables such as the location of fisheries closures and oyster bed contamination and closures, as well as the demographic composition of cleanup workers, and if waste disposal was not distributed across the region at many different facilities, a catastrophic oil-spill event may have disproportionate effects on minority and low-income populations.

B.3.1.26. Species Considered due to U.S. Fish and Wildlife Service Concerns

Phase 1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout incident. Impacts, response, and intervention depend on the spatial location of the blowout and leak. For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, this could result in a fire that would burn for 1 or 2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month. The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. Regardless of water depth, the immediate response would be from search and rescue vessels and aircraft, such as USCG cutters, helicopters, and rescue planes, and firefighting vessels. The potential impacts reflect the explosion, subsequent fire for 1-30 days, and the sinking of the platform in the immediate vicinity and up to 1 mi (1.6 km) from the well.

The scenarios for each phase, including cleanup methods, can be found **Table B-4**.

BOEM has only focused on species within coastal counties and parishes because those are the species that could be potentially impacted by oil and gas development activities, including a potential OCS spill. There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters. A catastrophic spill would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. The potential impacts reflect spill and response in Federal and State offshore waters. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response and oil initially reaching the shoreline during the spill event or while the oil still persists in the offshore environment once the spillage has been stopped. It is likely that Phases 2 and 3 could occur simultaneously. The duration of the initial shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. Re-oiling of already cleaned or previously impacted areas could be expected during Phase 3. In addition to the response described in Phase 2, nearshore and onshore efforts would be introduced in Phase 3 as oil entered coastal areas and contacted shore. The potential impacts reflect the spill and response in very shallow coastal waters and once along the shoreline. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

The FWS has explicitly communicated interest in specific species within State boundaries along the Gulf Coast. The species within Louisiana, Mississippi, Alabama, and Florida have been designated as endangered, threatened, candidate, listed with critical habitat, proposed nonessential experimental population, or distinct vertebrate population. The greatest threats to the majority of these species are the loss of and/or modification to suitable habitat caused by urban and agricultural development. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

At this time, there is no known record of a hurricane crossing the path of a large oil spill; the impacts of such have yet to be determined. The experience from Hurricanes Katrina and Rita in 2005 was that the oil released during the storms widely dispersed as far as the surge reached (USDOC, NOAA, National Weather Service, 2012). Due to their reliance on terrestrial habitats to carry out their life-history functions at a considerable distance from the GOM, the activities of a CPA proposed action are unlikely to have significant adverse effects on the size and recovery of any of the FWS-mentioned species or populations in Texas, Louisiana, Mississippi, Alabama, and Florida.

There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

Phase 4—Post-Spill, Long-Term Recovery and Response

Phase 4 focuses on long-term recovery once the well has been capped and the spill has stopped. During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and cleanup activities are concluding. While it is assumed that the majority of spilled oil would be dissipated offshore within 1-2 months (depending on season and temperature) of stopping the flow, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill. On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms. The potential impacts reflect long-term persistence of oil in the environment and residual and long-term cleanup efforts.

As data continue to be gathered and impact assessments completed, a better characterization of the full scope of impacts to populations in the GOM from the *Deepwater Horizon* explosion, oil spill, and response will be available. Relevant data on the status of populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this Supplemental EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM's subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches. Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this Supplemental EIS. The CPA is an active oil and gas region with ongoing (or the potential for) exploration, drilling, and production activities. In addition, non-OCS energy-related activities will continue to occur in the CPA irrespective of a CPA proposed action (i.e., habitat loss and competition). The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this Supplemental EIS.

There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 4 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

Overall Summary and Conclusion (Phases 1-4)

Accidental blowouts, oil spills, and spill-response activities resulting from a CPA proposed action have the potential to impact small to large areas 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 (including tropical storms). The incremental contribution of a CPA proposed action would not be likely to result in a significant incremental impact on the FWS-mentioned species within the CPA; in comparison, non-OCS oil- and gas-related activities, such as habitat loss and competition, have historically proved to be of greater threat to the FWS-mentioned species.

In conclusion, within the WPA, which is directly adjacent to the CPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting the FWS mentioned species populations; therefore, a CPA proposed action would be expected to have little or no effect on the FWS mentioned species.

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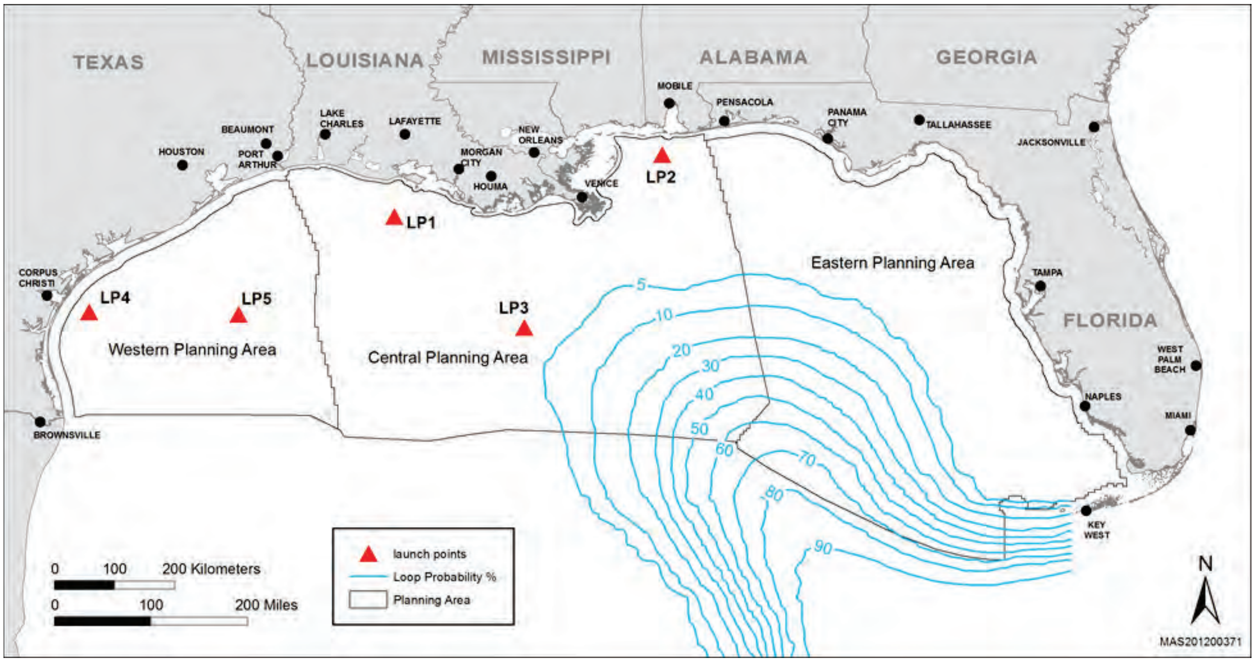

Figure B-1. Location of Five Hypothetical Oil-Spill Launch Points for OSRA within the Study Area. (Spatial variability of the Loop Current is from Vukovich [2007] and is shown as percent of time that the Loop Current watermass is associated with a particular location.)

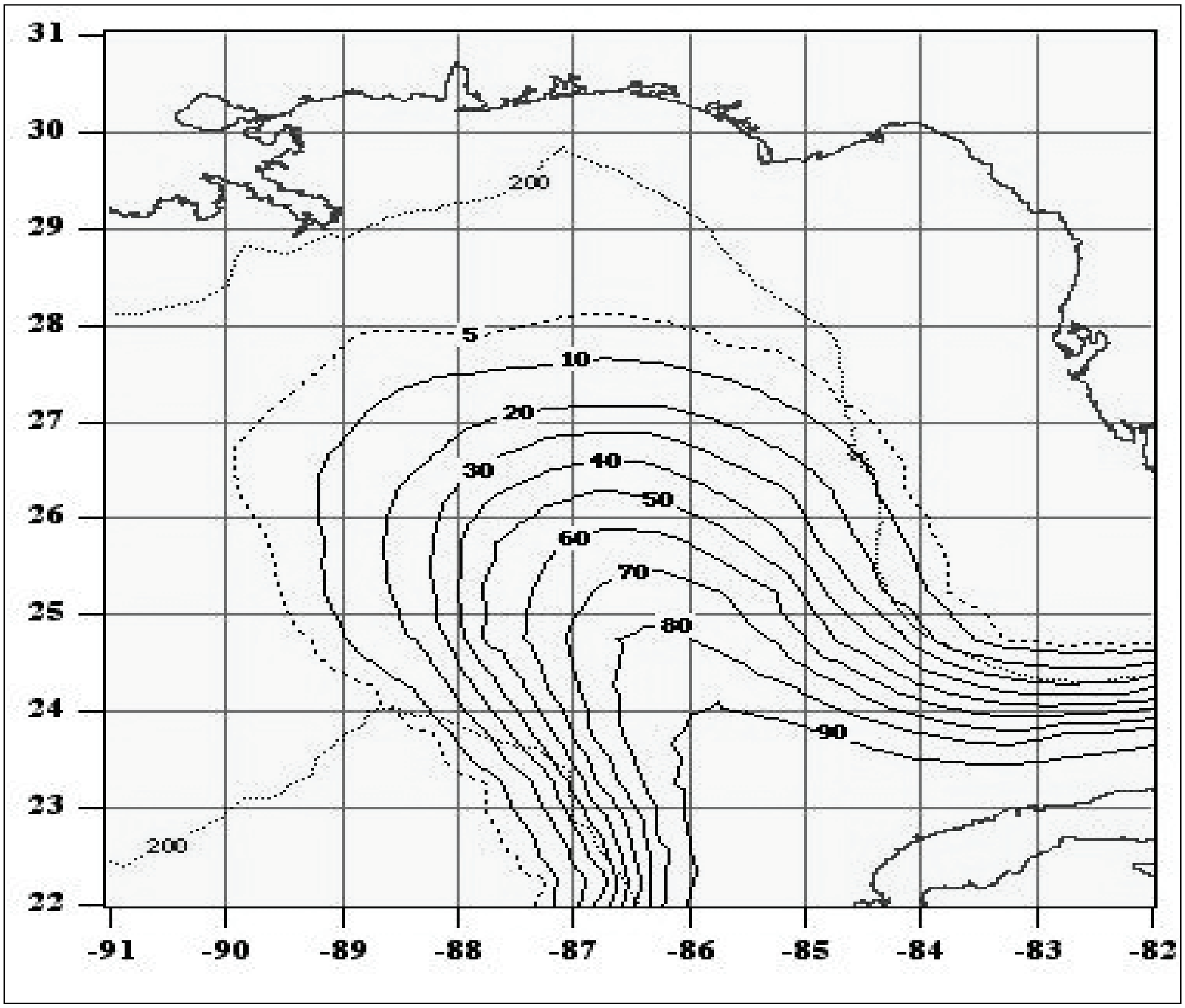

Figure B-2. Spatial Frequency (%) of the Watermass Associated with the Loop Current in the Eastern Gulf of Mexico based on Data for the Period 1976-2003 (Vukovich, 2005).

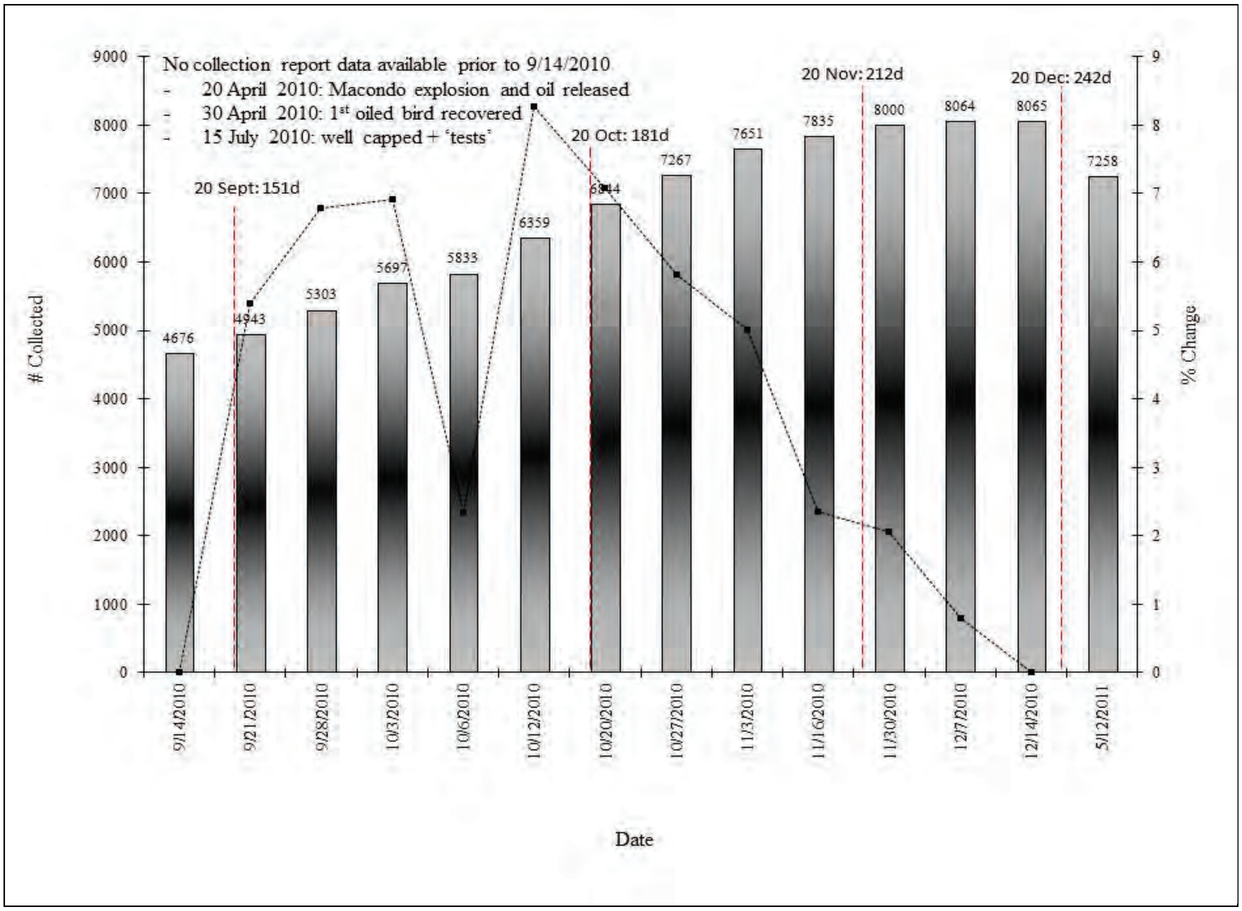

Figure B-3. Summary of Avian Species Collected by Date Obtained from the U.S. Fish and Wildlife Service as Part of the Deepwater Horizon Post-Spill Monitoring and Collection Process through May 12, 2011 (USDOI, FWS, 2011b). (This figure represents the date the data were released and reported and does not represent the actual date individual birds were collected. Data on the Y-axis reflects the cumulative # of individual birds collected, identified, and summarized by date; data on the Z-axis reflects proportional change from one reporting date to the next. The data used in this figure are verified as per FWS's QA/QC processes. The mean # of birds collected between intervals is 184.4 + 89.3 SE [-807 min, 526 max for 13 collection intervals] and the mean % change between intervals is 3.0 + 1.3% [-11.12% min., 8.27% max]. Unfortunately, we have no data on change in search effort temporally (or spatially) and also lack data prior to September 14, 2010; therefore, data at that point represent the baseline or "0" for determining interval differences. Disclaimer: All data should be considered provisional, incomplete, and subject to change. For more information, refer to FWS's Weekly Bird Impact Data and Consolidated Wildlife Reports [USDOI, FWS, 2011b]; for additional information on the chronological change in number of birds collected, refer to Belanger et al., 2010).

Table B-1

Blowout Scenarios and Key Differences in Impacts, Response, and/or Intervention

Location of Blowout and Leak	Key Differences in Impacts, Response, and/or Intervention
Blowout occurs at the sea surface (i.e., at the rig)	Offers the least chance for oil recovery because of the restricted access to the release point; therefore, greater impacts to coastal ecosystems. In addition to relief wells, there is potential for other intervention measures such as capping and possible manual activation of blowout-preventer (BOP) rams.
Blowout occurs along the riser anywhere from the seafloor to the sea surface. However, a severed riser would likely collapse, resulting in a leak at the seafloor.	In deep water, the use of subsea dispersants, if approved, may reduce impacts to coastal ecosystems; however, their use may increase exposure of deepwater marine resources to dispersed oil. There is a possibility for limited recovery of oil at the source. In addition to relief wells, there is potential for other intervention measures, such as capping and possible manual activation of BOP rams.
At the seafloor, through leak paths on the BOP/wellhead	In deep water, the use of subsea dispersant, if approved, may reduce impacts to coastal ecosystems; however, their use may increase exposure of deepwater marine resources to dispersed oil. With an intact subsea BOP, intervention may involve the use of drilling mud to kill the well. If the BOP and well stack are heavily compromised, the only intervention method may be relief wells. Greatest possibility for recovery of oil at the source, until the well is capped or killed.
Below the seafloor, outside the wellbore (i.e., broached)	Disturbance of a large amount of sediments resulting in the burial of benthic resources in the immediate vicinity of the blowout. The use of subsea dispersants would likely be more difficult (PCCI, 1999). Stopping this kind of blowout would probably involve relief wells. Any recovery of oil at the seabed would be very difficult.

Table B-2

Properties and Persistence by Oil Component Group

Properties and Persistence	Light-Weight	Medium-Weight	Heavy-Weight
Hydrocarbon Compounds	Up to 10 carbon atoms	10-22 carbon atoms	>20 carbon atoms
API º	>31.1º	31.1º-22.3º	<22.3º
Evaporation Rate	Rapid (within 1 day) and complete	Up to several days; not complete at ambient temperatures	Negligible
Solubility in Water	High	Low (at most a few milligrams/liter)	Negligible
Acute Toxicity	High because of monoaromatic hydrocarbons (BTEX)	Moderate because of diaromatic hydrocarbons (naphthalenes—2 ring PAH's)	Low except because of smothering (i.e., heavier oils may sink)
Chronic Toxicity	None, does not persist because of evaporation	PAH components (e.g., naphthalenes—2 ring PAH's)	PAH components (e.g., phenanthrene, anthracene—3 ring PAH's)
Bioaccumulation Potential	None, does not persist because of evaporation	Moderate	Low, may bioaccumulate through sediment sorption
Compositional Majority	Alkanes and cycloalkanes	Alkanes that are readily degraded	Waxes, asphaltenes, and polar compounds (not significantly bioavailable or toxic)
Persistence	Low because of evaporation	Alkanes readily degrade, but the diaromatic hydrocarbons are more persistent	High; very low degradation rates and can persist in sediments as tarballs or asphalt pavements

API = American Petroleum Institute.
BTEX = benzene, ethylbenzene, toluene, and xylene
PAH = polycyclic aromatic hydrocarbon

Sources: Michel, 1992; Canadian Center for Energy Information, 2010.

Table B-3

Annual Volume of Produced Water Discharged by Depth
(millions of barrels)

Year	Shelf 0-60 m	Shelf 60-200 m	Slope 200-400 m	Deepwater 400-800 m	Deepwater 800-1,600 m	Ultra-Deepwater 1,601-2,400 m	Ultra-Deepwater >2,400 m	Total
2000	370.6	193.1	35.5	25.6	12.2	0.0	0.0	637.0
2001	364.2	185.2	35.0	32.0	16.6	0.0	0.0	633.0
2002	344.6	180.4	32.5	35.2	21.4	0.0	0.0	614.1
2003	359.4	182.9	31.2	39.0	35.5	0.2	0.0	648.2
2004	346.7	160.5	29.3	36.9	39.2	1.9	0.0	614.5
2005	270.1	113.5	23.1	33.5	43.0	5.8	0.0	489.0
2006	260.3	99.7	20.6	35.1	61.5	12.4	0.0	489.6
2007	307.0	139.4	22.2	40.0	70.3	15.5	0.1	594.5
2008	252.7	118.6	15.9	32.7	60.1	16.5	0.1	496.6
2009	263.9	108.3	19.9	39.2	65.3	25.0	0.1	521.7

Source: USDOI, BOEMRE, 2010b.

Table B-4

Description of the Scenario for a Catastrophic Spill Event Occurring in Shallow Water or Deep Water
(assumptions are described in detail in the text)

Scenario	Shallow-Water Location	Deepwater Location
	Phase 1. Initial Event	
Vertical Location of Blowout	4 possible locations including sea surface, along the riser, at the seafloor, and below the seafloor	4 possible locations including sea surface, along the riser, at the seafloor, and below the seafloor
Duration of Uncontrolled Fire	1-30 days	1-30 days
	Phase 2. Offshore Spill	
Duration of Spill	2-5 months	4-6 months
Rate of Spill	30,000 bbl per day*	30,000-60,000 bbl per day
Total Volume of spill (1)	0.9-3.0 MMbbl crude oil	2.7-7.2 MMbbl crude oil 10,000-20,000 bbl diesel fuel
API° Gravity	Fresh oil will float (API° >10)	Fresh oil will float (API° >10)
Characteristics of Oil Released	Typical South Louisiana midrange paraffinic sweet crude oil	Typical South Louisiana midrange paraffinic sweet crude oil; crude properties changed after oil traveled up the wellbore and passed through the water column, undergoing rapid depressurization and turbulence. Oil reached the surface as an emulsion stripped of many of its volatile components.
Response		
Number of Vessels	Up to 3,000	Up to 7,000
Number of Workers	Up to 25,000	Up to 50,000
Number of Planes/Helicopters	25/50	50/100
Boom (million feet)	5	11
Dispersant Application (surface application) (2)	35,000 bbl	33,000-bbl surface application and 16,500-bbl subsea application
In-situ Burn	Yes, will occur	Yes, will occur
Vessel Decontamination Stations	Yes	Yes
Severe Weather	The potential for severe weather is noted, which could temporarily halt containment and response efforts.	The potential for severe weather is noted, which could temporarily halt containment and response efforts.
Fisheries Closure		During the peak, anticipate approximately 37% or 88,522 mi^2 (229,270 km^2) closed to recreational and commercial fishing.

Table B-4. Description of the Scenario for a Catastrophic Spill Event Occurring in Shallow Water or Deep Water (assumptions are described in detail in the text) (continued).

Scenario	Shallow-Water Location	Deepwater Location
Phase 3. Onshore Contact		
Shoreline Oiling Duration	1-5 months	3-6 months
Response		
Number of Staging areas	5-10	10-20
Number of Skimmers	200-300	500-600
Length of shoreline contacted		
	30 days[1] = 0-50 miles[2]	30 days[1] = 0-50 miles[2]
	60 days = 50-100 miles	60 days = 50-100 miles
	90 days = 100-1,000 miles	90 days = 100-1,000 miles
	120 days = >1,000 miles	120 days = >1,000 miles
	[1] Not cumulative. [2] Length was extrapolated	
Oil Characteristics and Appearance		—Essentially stable emulsions mixed with sand. —Typically initially stranded as surface layers and as discrete droplets/summer 2010.
Response Considerations for Sand Beaches	—No mechanical techniques allowed in some areas. —Much of the beach cleanup conducted at night. —Typically sand sieving, shaking, and sifting beach cleaning machines. —Repetitive tilling and mixing using agriculture plows and discs in combination with beach cleaning machines. —Sand washing treatment—sand sieve/shaker to remove debris and large oil particles and heated washing systems. —Nearshore submerged oil difficult to recover and hard to locate; vacuums and snares could be used.	—No mechanical techniques allowed in some areas. —Much of the beach cleanup conducted at night. —Typically sand sieving, shaking, and sifting beach cleaning machines. —Repetitive tilling and mixing using agriculture plows and discs in combination with beach cleaning machines. —Sand washing treatment—sand sieve/shaker to remove debris and large oil particles and heated washing systems. —Nearshore submerged oil difficult to recover and hard to locate; vacuums and snares could be used.
Response Considerations for Marshes	—Lightly oiled—allowed to recovery naturally; degrade in place or removed by tidal or wave action. —Moderately/heavily oiled—vacuumed or skimmed from boats possibly in conjunction with flushing; low-pressure flushing (with water comparable to marsh type); manual removal by	—Lightly oiled—allowed to recovery naturally; degrade in place or removed by tidal or wave action. —Moderately or heavily oiled—vacuumed or skimmed from boats possibly in conjunction with flushing; low-pressure flushing (with water comparable to marsh type); manual removal by hand or mechanized equipment; and vegetation cutting.

Table B-4. Description of the Scenario for a Catastrophic Spill Event Occurring in Shallow Water or Deep Water (assumptions are described in detail in the text) (continued).

	hand or mechanized equipment; and vegetation cutting. —Heavily oiled areas—in-situ burning may be an option if water covers the sediment surface. —Bioremediation may be utilized but mostly as a secondary treatment after bulk removal.	—Heavily oiled areas—in-situ burning may be an option if water covers the sediment surface. —Bioremediation may be utilized but mostly as a secondary treatment after bulk removal.
Response Considerations for Nearshore waters	Marsh areas—skimming and vacuum (in areas too shallow to use skimmers) systems used in conjunction with flushing, and booming to temporarily contain mobile slicks.	Marsh areas—skimming and vacuum (in areas too shallow to use skimmers) systems used in conjunction with flushing, and booming to temporarily contain mobile slicks.
Phase 4. Recovery Phase		
Remaining Sources of Unrecoverable Weathered Oil	Buried or in surface pockets in coastal sand, sediment, or muddy bottoms and in pockets on the seafloor.	Buried or in surface pockets in coastal sand, sediment, or muddy bottoms and in pockets on the seafloor.
Oil Characteristics and Appearance		As stranded oil weathered, some became buried through natural beach processes and appeared as surface residual balls (SRB) <10 cm (4 in) or as patties (SRP) 10 cm-1 m (4 in-3 ft).
Response Considerations for Sand Beaches, Marshes, and Nearshore Waters	See Phase 3 above.	See Phase 3 above.

(1) A blowout may contain crude oil, natural gas, and condensate. Because the majority of environmental damage is due to the release of oil, this text assumes the spill to be an oil spill. However, a natural gas release would result in a less visible and less persistent adverse impact than an oil release.
(2) Subsea dispersal application must be individually approved.

Table B-5

Birds Collected and Summarized by the U.S. Fish and Wildlife Service:
Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2]

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Amer. Coot	Marsh/Wading	3	2	2	2	0	0	0	1	0	1	0.67
Amer. Oystercatcher	Shorebird	13	7	3	7	3	0	3	1	3	3	0.54
Amer. Redstart	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Amer. White Pelican	Seabird	19	5	3	8	4	0	4	4	8	7	0.42
Audubon's Shearwater	Seabird	36	1	1	1	35	0	35	0	2	0	0.03
Barn Owl	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Barn Swallow	Passerine	1	1	0	1	0	0	0	0	0	0	1.00
Belted Kingfisher	Passerine	1	0	0	0	1	0	1	0	1	0	0.00
Bl.-crown. Night Heron	Marsh/Wading	18	6	3	8	7	0	7	1	4	3	0.44
Black Skimmer	**Seabird**	**253**	**51**	**16**	**55**	**153**	**0**	**153**	**40**	**14**	**45**	**0.22**
Black Tern	Seabird	9	1	0	1	7	0	7	1	3	1	0.11
Bl.-bell. Whistl. Duck	Waterfowl	2	0	0	0	0	0	0	0	2	2	0.00
Black-necked Stilt	Shorebird	3	0	0	0	3	0	3	0	0	0	0.00
Blue-winged Teal	Waterfowl	6	0	0	0	6	0	6	0	0	0	0.00
Boat-tailed Grackle	Passerine	1	0	0	0	1	0	1	0	1	0	0.00
Broad-winged Hawk	Raptor	1	0	0	0	1	0	1	0	1	0	0.00
Brown Pelican	**Seabird**	**826**	**152**	**227**	**339**	**248**	**0**	**248**	**177**	**149**	**239**	**0.41**
Brown-headed Cowbird	Passerine	1	0	0	0	0	0	0	0	1	1	0.00
Bufflehead	Waterfowl	1	0	1	1	0	0	0	0	0	0	1.00
Canada Goose	Waterfowl	4	0	1	1	1	0	1	1	2	2	0.25
Caspian Tern	Seabird	17	7	3	8	4	0	4	2	6	5	0.47
Cattle Egret	Marsh/Wading	36	4	4	7	25	0	25	3	4	4	0.19
Clapper Rail	Marsh/Wading	120	27	5	29	64	0	64	20	14	27	0.24

Table B-5. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Common Loon	Diving	75	33	27	39	24	0	24	4	20	12	0.52
Common Moorhen	Marsh/Wading	4	1	0	1	3	0	3	0	0	0	0.25
Common Nighthawk	Passerine	1	0	0	0	0	0	0	0	1	1	0.00
Common Tern	Seabird	25	15	12	16	9	0	9	0	0	0	0.64
Common Yellowthroat	Passerine	2	0	0	0	2	0	2	0	0	0	0.00
Cooper's Hawk	Raptor	1	0	0	0	1	0	1	0	1	0	0.00
Cory's Shearwater	Seabird	4	0	0	0	3	0	3	0	1	1	0.00
Dbl-crest. Cormorant	Diving	23	2	1	2	17	0	17	2	7	4	0.09
Eastern Kingbird	Passerine	2	1	0	1	1	0	1	0	0	0	0.50
Eastern Meadowlark	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Eur. Collared-dove	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Eur. Starling	Passerine	2	0	1	1	1	0	1	0	0	0	0.50
Forster's Tern	Seabird	40	17	8	20	12	0	12	6	7	8	0.50
Fulvous Whistl. Duck	Waterfowl	1	0	0	0	0	0	0	0	1	1	0.00
Glossy Ibis	Marsh/Wading	2	1	1	1	1	0	1	0	0	0	0.50
Great Blue Heron	Marsh/Wading	42	5	3	6	26	0	26	4	16	10	0.14
Great Cormorant	Diving	1	0	0	0	1	0	1	0	0	0	0.00
Great Egret	Marsh/Wading	31	6	6	7	15	0	15	8	3	9	0.23
Great-horned Owl	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Greater Shearwater	Seabird	89	7	4	7	55	0	55	27	4	27	0.08
Green Heron	Marsh/Wading	16	2	0	2	8	0	8	1	6	6	0.13
Gull-billed Tern	Seabird	4	0	0	0	2	0	2	2	4	2	0.00
Herring Gull	Seabird	31	10	11	13	10	0	10	2	13	8	0.42
House Sparrow	Passerine	2	0	0	0	2	0	2	0	1	0	0.00
Killdeer	Shorebird	3	0	0	0	3	0	3	0	0	0	0.00

Table B-5. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
King rail	Marsh/Wading	1	0	0	0	0	0	0	0	1	1	0.00
Laughing Gull	**Seabird**	**2,981**	**1,025**	**355**	**1,182**	**1,390**	**0**	**1,390**	**304**	**371**	**409**	**0.40**
Leach's Storm-petrel	Seabird	1	1	0	1	0	0	0	0	1	0	1.00
Least Bittern	Marsh/Wading	4	0	0	0	4	0	4	0	2	0	0.00
Least Tern	Seabird	106	46	7	49	43	0	43	12	3	14	0.46
Less. Bl.-backed Gull	Seabird	4	1	1	1	1	0	1	1	2	2	0.25
Less. Scaup	Waterfowl	1	0	0	0	0	0	0	1	0	1	0.00
Little Blue Heron	Marsh/Wading	5	0	0	0	4	0	4	1	1	1	0.00
Long-bill. Dowitcher	Shorebird	1	0	0	0	0	0	0	0	1	1	0.00
Magnif. Frigatebird	Seabird	8	3	3	4	2	0	2	1	2	2	0.50
Mallard	Waterfowl	26	5	4	6	16	0	16	0	7	4	0.23
Manx Shearwater	Seabird	6	1	0	1	5	0	5	0	0	0	0.17
Masked Booby	Seabird	9	4	3	4	1	0	1	0	4	4	0.44
Mottled Duck	Waterfowl	6	0	0	0	5	0	5	1	1	1	0.00
Mourning Dove	Passerine	15	3	1	3	8	0	8	0	6	4	0.20
Muscovy Duck	Waterfowl	1	0	0	0	1	0	1	0	1	0	0.00
Neotropic Cormorant	Diving	5	0	0	0	2	0	2	3	0	3	0.00
Northern Cardinal	Passerine	3	0	0	0	3	0	3	0	0	0	0.00
Northern Gannet	**Seabird**	**475**	**225**	**189**	**297**	**99**	**0**	**99**	**30**	**107**	**79**	**0.63**
Northern Mockingbird	Passerine	5	0	0	0	4	0	4	0	2	1	0.00
Osprey	Raptor	11	2	1	3	6	0	6	0	3	2	0.27
Pied-billed Grebe	Diving	32	18	24	24	7	0	7	1	3	1	0.75
Piping Plover	Shorebird	1	0	0	0	1	0	1	0	0	0	0.00
Purple Gallinule	Marsh/Wading	2	0	0	0	2	0	2	0	0	0	0.00
Purple Martin	Passerine	5	1	0	1	3	0	3	0	1	1	0.20

Table B-5. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Red-breasted Merg.	Waterfowl	2	1	1	1	1	0	1	0	1	0	0.50
Reddish Egret	Marsh/Wading	2	1	1	1	1	0	1	0	1	0	0.50
Red-shouldered Hawk	Raptor	1	0	0	0	0	0	0	0	1	1	0.00
Red-tailed Hawk	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Red-winged Blackbird	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Ring-billed Gull	Seabird	2	0	1	1	1	0	1	0	0	0	0.50
Rock Dove (pigeon)	Passerine	16	2	2	3	4	0	4	2	10	9	0.19
Roseate Spoonbill	Marsh/Wading	15	7	3	7	3	0	3	5	1	5	0.47
Royal Tern	**Seabird**	**289**	**116**	**66**	**149**	**104**	**0**	**104**	**19**	**47**	**36**	**0.52**
Ruddy Duck	Waterfowl	1	1	0	1	0	0	0	0	0	0	1.00
Ruddy Turnstone	Shorebird	13	1	3	3	8	0	8	1	5	2	0.23
Sanderling	Shorebird	26	4	2	4	20	0	20	1	6	2	0.15
Sandwich Tern	Seabird	70	28	20	34	25	0	25	8	14	11	0.49
Seaside Sparrow	Passerine	9	4	0	4	5	0	5	0	0	0	0.44
Semipalm. Sandpiper	Shorebird	3	2	1	3	0	0	0	0	0	0	1.00
Short-bill. Dowitcher	Shorebird	1	0	0	0	1	0	1	0	0	0	0.00
Snowy Egret	Marsh/Wading	22	12	9	14	6	0	6	2	3	2	0.64
Sooty Shearwater	Seabird	1	0	0	0	0	0	0	0	1	1	0.00
Sooty Tern	Seabird	3	0	1	1	2	0	2	0	1	0	0.33
Sora	Marsh/Wading	5	2	1	2	1	0	1	2	0	2	0.40
Spotted Sandpiper	Shorebird	1	0	0	0	1	0	1	0	0	0	0.00
Surf Scoter	Waterfowl	1	1	1	1	0	0	0	0	0	0	1.00
Tri-colored Heron	Marsh/Wading	31	9	5	11	7	0	7	11	2	13	0.35
Virginia Rail	Marsh/Wading	3	0	0	0	3	0	3	0	1	0	0.00
White Ibis	Marsh/Wading	7	1	1	1	4	0	4	2	3	2	0.14

Table B-5. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
White-tail. Tropicbird	Seabird	1	0	0	0	1	0	1	0	0	0	0.00
White-wing. Dove	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Willet	Shorebird	13	2	1	3	8	0	8	1	3	2	0.23
Wilson's Plover	Shorebird	3	0	0	0	2	0	2	1	0	1	0.00
Yellow-billed Cuckoo	Passerine	2	2	0	2	0	0	0	0	0	0	1.00
Yel.-cr. Night Heron	Marsh/Wading	9	1	0	1	7	0	7	0	3	1	0.11
Unid. Blackbird	Passerine	1	0	0	0	0	0	0	0	1	1	0.00
Unid. Booby	Seabird	1	0	0	0	1	0	1	0	1	0	0.00
Unid. Cormorant	Diving	14	3	0	3	10	0	10	1	0	1	0.21
Unid. Dowitcher	Shorebird	2	1	0	1	1	0	1	0	1	0	0.50
Unid. Duck	Waterfowl	2	0	0	0	1	0	1	1	0	1	0.00
Unid. Egret	Marsh/Wading	15	2	0	2	11	0	11	2	1	2	0.13
Unid. Flycatcher	Passerine	1	1	0	1	0	0	0	0	0	0	1.00
Unid. Grebe	Diving	4	2	1	2	2	0	2	0	0	0	0.50
Unid. Gull	Seabird	248	79	1	80	134	0	134	33	4	34	0.32
Unid. Hawk	Raptor	2	0	0	0	2	0	2	0	0	0	0.00
Unid. Heron	Marsh/Wading	15	5	0	5	8	0	8	1	1	2	0.33
Unid. Loon	Diving	7	2	2	4	3	0	3	0	1	0	0.57
Unid. Mockingbird	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Owl	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Passerine	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Pelican	Seabird	25	5	1	5	15	0	15	4	1	5	0.20
Unid. Pigeon	Passerine	14	2	1	3	6	0	6	1	6	5	0.21
Unid. Rail	Marsh/Wading	4	1	0	1	3	0	3	0	0	0	0.25
Unid. Raptor	Raptor	1	0	0	0	1	0	1	0	0	0	0.00

Table B-5. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Unid. Sandpiper	Shorebird	2	0	0	0	2	0	2	0	2	0	0.00
Unid. Shearwater	Seabird	6	0	0	0	5	0	5	1	0	1	0.00
Unid. Shorebird	Shorebird	3	2	0	2	0	0	0	1	0	1	0.67
Unid. Skimmer	Seabird	6	0	0	0	5	0	5	1	0	1	0.00
Unid. Sparrow	Passerine	3	0	0	0	1	0	1	2	0	2	0.00
Unid. Swallow	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Tern	Seabird	132	38	1	39	79	0	79	13	2	14	0.30
Unid. Warbler	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unknown spp.		593	51	2	53	451	0	451	88	1	89	0.09
Other		106	31	3	34	52	0	52	7	14	20	0.32
Column Totals		7,258	2,121		2,642	3,387		3,387	873		1,229	0.24

[1] Data obtained from the U.S. Fish and Wildlife Service (FWS) as part of the *Deepwater Horizon* post-spill monitoring and collection process are summarized for May 12, 2011 (USDOI, FWS, 2011). The data used in this table are verified as per FWS's QA/QC processes. Disclaimer: All data should be considered provisional, incomplete, and subject to change (USDOI, FWS, 2011). For more information, refer to the Weekly Bird Impact Data and Consolidated Wildlife Reports. Numbers in this table have been verified against the original data from FWS's website (USDOI, FWS, 2011).

[2] As of May 12, 2011, 104 avian species had been collected and identified through the *Deepwater Horizon* post-spill monitoring and collection process (USDOI, FWS, 2011). Note: Though the process was triggered by the *Deepwater Horizon* explosion and oil spill, not all birds recovered were oiled (36% = oiled, 47% = unoiled, 17% = unknown), suggesting that "search effort" alone accounted for a large proportion of the total (n = 7,258) birds collected (Piatt et al., 1990a, page 127). Some of the live birds collected may have been incapable of flight due to age or molt, and some of the dead birds collected may have died due to natural mortality, predation, or other anthropogenic sources of mortality. The overall oiling rate across species including "others" and "unknowns" was 0.24 versus 0.25 for individuals identified to species. The oiling rate for the **Top 5** (see bold rows in table) most-impacted avian species was 0.43 and included representatives only from the seabird group. These are listed in descending order based on the number collected: laughing gull (2,981 collected, 0.40 oiling rate); brown pelican (826 collected, 0.41 oiling rate); northern gannet (475 collected, 0.63 oiling rate); royal tern (289 collected, 0.52 oiling rate); and black skimmer (253 collected, 0.22 oiling rate). Note: There is a difference between the table structure here compared with the original table on FWS's website. Herein, columns for live birds that later died were not included. Totals associated with each larger grouping are correct and sum to those column totals for the May 12, 2011, Collection Report values. Six new species or rows were added and 3 species were removed between the December 14, 2010, Collection Report (USDOI, FWS, 2010) and the May 12, 2011, Collection Report (USDOI, FWS, 2011). The major difference in number (-807) between the more recent and older versions was due to an ~10% overestimate in the previous report representing live birds that later died, as these individuals were counted twice in the December 14, 2010, Collection Report (USDOI, FWS, 2010).

[3] For additional information on oiling rates by Species Group and additional statistics, refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS.

Table B-5. Birds Collected and Summarized by the U.S. Fish and Wildlife Service Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

[4] Oiling Rate: For each species, an oiling rate was calculated by dividing the "total" number of oiled individuals (∑ alive + dead) /∑ of total individuals collected for a given species/row. In general, it has been well documented that the number of birds collected after a spill event represents a small fraction of the total oiled population (direct mortality) due to various factors: species-specific differences in vulnerability to spilled oil, species-specific differences in distribution, habitat use and behavior; species-specific differences in abundance; species-specific differences in carcass deposition rates, persistence rates, and detection probabilities; overall search effort and temporal and spatial variation in search effort; and carcass loss due to predation, habitat, weather, tides, and currents (Piatt et al., 1990a and 1990b; Ford et al., 1996; Piatt and Ford, 1996; Fowler and Flint, 1997; Flint and Fowler, 1998; Flint et al., 1999; Hampton and Zafonte, 2005; Ford, 2006; Castege et al., 2007; Ford and Zafonte, 2009; Byrd et al., 2009; Flint et al., 2010). For example, Piatt and Ford (1996, Table 1) estimated a mean carcass recovery rate of only 17% for a number of previous oil-bird impact studies. Burger (1993) and Weise and Jones (2001) estimated recovery rates of 20% with the latter study based on a drift-block design to estimate carcass recovery rate from beached-bird surveys. Due to the fact that the coastline directly inshore of the well blowout location is primarily marsh and not sandy beaches, due to the distance from the blowout location to the coast, and due to predominant currents and wind directions during the event, the number of birds collected will likely represent a recovery estimate in the lower ranges of those provided in the literature to date (≤10%). A range of mortality estimates given the total number of dead birds collected through May 12, 2011, of 7,258 birds x recovery rates from the literature (0-59% in Piatt and Ford, 1996, Table 1) suggests a lower range of 12,302 birds* (59% recovery rate), an upper range of 725,800 birds* (0% recovery rate), and 42,694 birds based on the 17% mean recovery rate from Piatt and Ford (1996). The lower range of estimates (i.e., high carcass recovery rates) is likely biased low because it assumes no search effort after May 2011 (i.e., no more birds were collected after that date) and does not account for any of the detection probability parameters that are currently unknown. The actual avian mortality estimate will likely not be available until the Natural Resource Damage Assessment (NRDA) process has been completed; this should include a combination of carcass drift experiments, drift-block experiments, corrections for carcass deposition and persistence rates, scavenger rates, and detection probability with additional modeling to more precisely derive an estimate. For additional information on oiling rates by Species Group and additional statistics, refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS. Note: Spill volume tends to be a poor predictor of bird mortality associated with an oil spill (Burger, 1993), though it should be considered for inclusion in any models to estimate total bird mortality, preferably with some metric of species composition and abundance (preferably density) pre-spill (Wilhelm et al., 2007).

* Corrected values are based on revisiting the original calculations after publication of the 2012-2017 WPA/CPA Multisale EIS. An additional estimate for total mortality based on Piatt and Ford (1996) is also provided.

Table B-6

Federally Listed Avian Species Considered by State and Associated Planning Area in the Gulf of Mexico[1]

Species	Status	Critical Habitat	IUCN Red List Status[2]	States	Planning Area
Red-cockaded Woodpecker	Endangered	No rules published	Vulnerable	AL, FL, LA, MS, TX	WPA, CPA, EPA
Least Tern[3]	Endangered	No rules published	Least Concern	AL, LA, TX (FL, MS)	WPA, CPA, EPA
Piping Plover	Threatened	Designated	Near Threatened	AL, FL, LA, MS, TX	WPA, CPA, EPA
Roseate Tern	Threatened	No rules published	Least Concern	FL only	EPA
Wood Stork	Endangered	No rules published	Least Concern	AL, FL, MS	CPA, EPA
Whooping Crane	Endangered	Designated	Endangered	TX, LA[4], FL[4]	WPA, CPA, EPA
Mississippi Sandhill Crane	Endangered	Designated	Not Yet Assessed	MS only	CPA
Attwater's Prairie Chicken	Endangered	No rules published	Not Yet Assessed	TX only	WPA
N. Aplomado Falcon	Endangered	No rules published	Not Yet Assessed	TX only	WPA
Everglades Snail Kite	Endangered	Designated	Not Yet Assessed	FL only	EPA
Cape Sable Seaside Sparrow	Endangered	Designated	Not Yet Assessed	FL only	EPA
Audubon's Crested Caracara	Threatened	No rules published	Not Yet Assessed	FL only	EPA
Sprague's Pipit	Candidate	NA – Priority 2	Vulnerable	LA, TX	WPA, CPA
Bald Eagle	Delisted	No rules published	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Peregrine Falcon	Delisted	Designated	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Eastern Brown Pelican	Delisted	No rules published	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Red Knot	Proposed Threatened	NA – proposed threatened	Least Concern	FL, LA, TX	WPA, CPA, EPA

[1] Information contained in this table was obtained via an email attachment from the U.S. Fish and Wildlife Service (FWS) on April 6, 2012 (USDOI, FWS, 2012) and from FWS's "Endangered Species" website and associated queries for "species" available from FWS's website (USDOI, FWS, 2011c). Additional information for each species can be found at NatureServe Explorer (2011). Note: All species listed in this table are considered, but only the piping plover, roseate tern, whooping crane, wood stork, Mississippi sandhill crane, bald eagle, eastern brown pelican, and red knot will be analyzed.

[2] International Union for Conservation of Nature (IUCN) – The Red List classifies species as imperiled (Critically Endangered, Endangered, or Vulnerable), not imperiled (Near Threatened or Least Concern), extinct (Extinct, Extinct in the Wild), or Data Deficient (Butchart et al., 2004 and 2005; Harris et al., 2012). If species meet the quantitative thresholds of any of the following criteria, they will be added to the Red List: (1) decline in population size; (2) small geographic range; (3) small population size plus decline; (4) very small population size; or (5) quantitative analysis.

[3] The Interior population of the least tern was listed as endangered on May 28, 1985 (*Federal Register*, 1985) throughout much of its breeding range in the Midwest. This designation does not provide or extend Endangered Species Act (ESA) protection to the breeding population of Gulf Coast "population" of least terns. Similarly, ESA protection for breeding least terns only applies to certain segments or areas (inland rivers and lakes ~50 mi [80 km] inland) of Louisiana, Mississippi, and Texas.

[4] The whooping crane is considered endangered throughout its range in the U.S. except where nonessential, experimental flocks have been established. More recently, a release site (White Lake Wetlands Conservation Area, Vermilion Parish) was added in Louisiana (Table 4-14 of the 2012-2017 WPA/CPA Multisale EIS) with a release of 10 birds on February 22, 2011. To date, only 3 of the original 10 released cranes remain; an additional release of 16 cranes occurred on December 1, 2011. The Gulf Coast States that have these nonessential, experimental flocks include Alabama, Louisiana, Mississippi, and Florida; as well, wild whooping cranes may rarely occur as transients in Mississippi and Alabama, but they are not known to breed in either state.

[5] The red knot is currently a proposed threatened species as of September 30, 2013 (*Federal Register,* 2013).

APPENDIX C

BOEM-OSRA CATASTROPHIC RUN

C. BOEM-OSRA CATASTROPHIC RUN

A special Oil-Spill Risk Analysis (OSRA) run was conducted in order to estimate the impacts of a possible future catastrophic or high-volume, long-duration oil spill. Thus, assuming a hypothetical high-volume, long-duration oil spill occurred, this analysis emphasized modeling a spill that continued for 90 consecutive days, with each trajectory tracked for up to 60 days. The analysis was conducted for the trajectories of oil spills from seven hypothetical spill locations to various onshore and offshore environmental resources. The probability of an oil spill contacting a specific resource within a given time of travel from a spill point is termed a conditional probability; the condition being that a spill is assumed to have occurred. Each trajectory was allowed to continue for as long as 60 days. However, if the hypothetical spill contacted shoreline sooner than 60 days after the start of the spill, the spill trajectory was terminated, and the contact was recorded. Although, overall OSRA is designed for use as a risk-based assessment, for this analysis, only the conditional probability, the probability of contact to the resource, was calculated. The probability of a catastrophic spill occurring was not calculated; thus, the combination of the probability of a spill and the probability of contact to the resources from the hypothetical spill locations were not calculated. Results from this trajectory analysis provide input to the final product by estimating where spills might travel on the ocean's surface and what environmental resources might be contacted if and when another catastrophic spill occurs, but it does not provide input on the probability of another catastrophic spill occurring.

Catastrophic OSRA Run Methods

The OSRA model, originally developed by Smith et al. (1982) and enhanced by this Agency over the years (Ji et al., 2002, 2004a, 2004b, and 2011), simulates oil-spill transport using model-simulated winds and ocean currents in the Gulf of Mexico. An oil spill on the ocean surface is moved around by the complex surface ocean currents exerting a shear force on the spilled oil from below. In addition, the prevailing wind exerts an additional shear force on the spill from above, and the combination of the two forces causes the transportation of the oil spill away from its initial spill location. In the OSRA model, the velocity of a hypothetical oil spill is the linear superposition of the surface ocean current and the wind drift caused by the winds. The model calculates the movement of hypothetical spills by successively integrating time sequences of two spatially gridded input fields: the surface ocean currents and the sea-level winds. Thus, the OSRA model generates time sequences of hypothetical oil-spill locations—essentially, oil-spill trajectories.

At each successive time step, the OSRA model compares the location of the hypothetical spills against the geographic boundaries of onshore and offshore environmental resources. Resource locations are the same as for the typical OSRA run. The frequencies of oil-spill contact are computed for designated oil-spill travel times (e.g., 3, 10, 30, or 60 days) by dividing the total number of oil-spill contacts by the total number of hypothetical spills initiated in the model from a given hypothetical spill location. The frequencies of oil-spill contact are the model-estimated probabilities of oil-spill contact. The OSRA model output provides the estimated probabilities of contact to resources from five launch points (LP) in the Western and Central Planning Areas (**Figure C-1**).

The trajectories simulated by the OSRA model represent only hypothetical pathways of oil slicks; they do not involve any direct consideration of cleanup, dispersion, or weathering processes that could alter the quantity or properties of oil that might eventually contact the environmental resource locations. However, an implicit analysis of weathering and spill degradation can be considered by choosing a travel time for the simulated oil spills when they contact environmental resource locations that represent the likely persistence of the oil slick on the water surface.

Oil spill runs with weathering were performed using the Spill Impact Model System (SIMAP) software (Applied Science Associates, Inc., 2012) in order to determine a reasonable length of time for simulating the trajectories for the catastrophic OSRA runs. Based on the SIMAP spill scenario runs, 60 days was chosen as the longest spill travel time for the catastrophic OSRA runs. For each scenario run, SIMAP was used to simulate surface oil trajectories from input current and wind fields and weathering processes, including evaporation, dispersion, dissolution, and natural degradation. To compute the weathering assumption for the catastrophic OSRA run, 12 different scenarios were performed (1 in each season from 1993 through 1995), using a spill size of 60,000 bbl, a spill duration of

24 hours, and a South Louisiana Crude (light) oil. Based on these runs, a conservative estimate of 60 days was chosen as the length of time that oil would likely persist floating on the surface following a catastrophic spill. For comparison, 19 days was the calculated persistence time of *Deepwater Horizon* oil on the water's surface (**Chapter 3.2.1.5.4**), and a 30-day catastrophic OSRA run has previously been used to simulate that particular spill event, which occurred in spring through early summer (Ji et al., 2011).

In the trajectory simulation portion of the OSRA model, many hypothetical oil-spill trajectories are produced by numerically integrating a temporally and spatially varying ocean current field, and superposing on that an empirical wind-induced drift of the hypothetical oil spills (Samuels et al., 1982). Collectively, the trajectories represent a statistical ensemble of simulated oil-spill displacements produced by a field of numerically derived winds and ocean currents. The winds and currents are assumed to be statistically similar to those that will occur in the Gulf during future offshore activities. In other words, the oil-spill risk analysts assume that the frequency of strong wind events in the wind field is the same as what will occur during future offshore activities. By inference, the frequencies of contact by the simulated oil spills are the same as what could occur from actual oil spills during future offshore activities.

Another portion of the OSRA model tabulates the contacts by the simulated oil spills. A contact to shore will stop the trajectory of an oil spill; no re-washing is assumed in this model. After specified periods of time, the OSRA model will divide the total number of contacts to the environmental resources by the total number of simulated oil spills from each of the LP's. These ratios are the estimated probabilities of oil-spill contact from offshore activities at that geographic location, assuming spill occurrence.

Detailed information on ocean currents and wind fields is needed when conducting an oil-spill risk analysis (Ji, 2004). The ocean currents used are numerically computed from an ocean circulation model of the Gulf of Mexico driven by analyzed meteorological forces (the near-surface winds and the total heat fluxes) and observed river inflow into the Gulf of Mexico (Oey, 2005 and 2008). The models used are versions of the Princeton Ocean Model, which is an enhanced version of the earlier constructed Mellor-Blumberg Model.

The ocean model calculation was performed by Princeton University (Oey, 2005 and 2008). This simulation covered the 14-year period of 1993 through 2006, and the results were saved at 3-hour intervals. This run included the assimilation of sea-surface altimeter observations to improve the ocean model results. The surface currents were then computed for input into the OSRA model, along with the concurrent wind field. The OSRA model used the same wind field to calculate the empirical wind drift of the simulated spills. The statistics for the contacts by the trajectories forced by the currents and winds were combined for the average probabilities.

Trajectories of hypothetical spills were initiated every 1.0 day from each of the launch points over the 14-year simulation period from January 1, 1993, to December 31, 2006. The chosen number of trajectories per site was small enough to be computationally practical and large enough to reduce the random sampling error to an insignificant level. Also, the weather-scale changes in the winds are at least minimally sampled, with simulated spills started every 1.0 day.

Five launch point locations (LP 1-5) were developed for the Western and Central Planning Areas. The locations were determined based on the approximate areas with the possibility of finding the largest oil volume within each planning area. The launch point locations are as follows:

Description	Longitude (DD)	Latitude (DD)	Launch Point (LP)
Central Planning Area (west of Mississippi River)	-92.17851	28.98660	1
Central Planning Area (east of Mississippi River)	-88.15338	29.91388	2
Central Planning Area (slope area)	-90.22203	27.31998	3
Western Planning Area (shelf area)	-96.76627	27.55423	4
Western Planning Area (slope area)	-94.51836	27.51367	5

DD = decimal degrees.

The methodology used for launch point selection is not part of the OSRA model in the manner it has been typically run for this Agency's spill analyses. Gulf of Mexico OCS Region geologists and engineers used the following methodology to select launch point locations. BOEM's Office of Resource Evaluation applied their Undiscovered Resource Distribution Methodology to identify a location within the proposed lease sale area where the potential for a large undiscovered oil volume may exist. For each geologic play, the undiscovered technically recoverable resource volume is distributed throughout the play using a statistical allocation process that is based on the likelihood of future oil discovery potential. The probability factors used to allocate undiscovered oil volumes to specific areas within the geologic play is based on the pool-density of existing discoveries, the density of undrilled prospects on leased acreage, and the results from recent exploration drilling activity. In areas where the potential for undiscovered technically recoverable resource volume exists for more than one geologic play, the oil volumes are aggregated. Results from the aggregation were used to identify geographic areas of high potential for future oil discoveries: three in the Central Planning Area and two in the Western Planning Area of the Gulf of Mexico. Although these areas may encompass hundreds of square miles, the coordinates for the five launch points were selected qualitatively to correspond with the centroid of these areas.

Catastrophic OSRA Results

Based on the weathering analyses (described above), OSRA model trajectories were analyzed up to 60 days, and any spill contacts occurring during this elapsed time are reported in the probability tables (**Tables C-1 through C-10**). Conditional probabilities of contact with environmental resources within 60 days of travel time were calculated for each of the hypothetical spill sites. The probability estimates were tabulated for the 60-day trajectories, as averages for the 14 years of the analysis from 1993 to 2006. The groupings were treated as seasonal probabilities that corresponded with quarters of the year: Spring, (April, May, and June); Summer, (July, August, and September); Fall, (October, November, and December); and Winter, (January, February, and March). These 3-month probabilities can be used to estimate the average contact with environmental resources during a spill, treated as one spill occurring each day for 90 days, within the quarter. The seasonal quarterly groupings take account of the differing meteorological and oceanographic conditions (wind and current patterns) during the year (**Figures C-2 through C-6**). As well, annualized conditional probabilities provide a useful single picture of average probabilities across the entire year from each launch point (**Figures C-7 through C-11**).

As one might expect, environmental resources closest to the spill sites typically have the greatest risk of contact (**Tables C-1 through C-10**). As the model run duration increases, more of the resources could have meaningful probabilities of contact (≥0.5%). It should be reiterated that these are conditional probabilities; the condition being that a spill is assumed to have occurred. The longer transit times up to 60 days allowed by the model enable hypothetical spills to reach the environmental resources and the shoreline from more distant spill locations. With increased travel time, the complex patterns of wind and ocean currents produce eddy-like motions of the oil spills and multiple opportunities for a spill to make contact with shoreline segments. For some launch points and for the travel times greater than 30 days, the probability of contact to land decreases very slowly or remains constant because the early contacts to land have occurred within 30 days, and the trajectories that have not contacted land within 30 days will remain at sea for 60 days or more.

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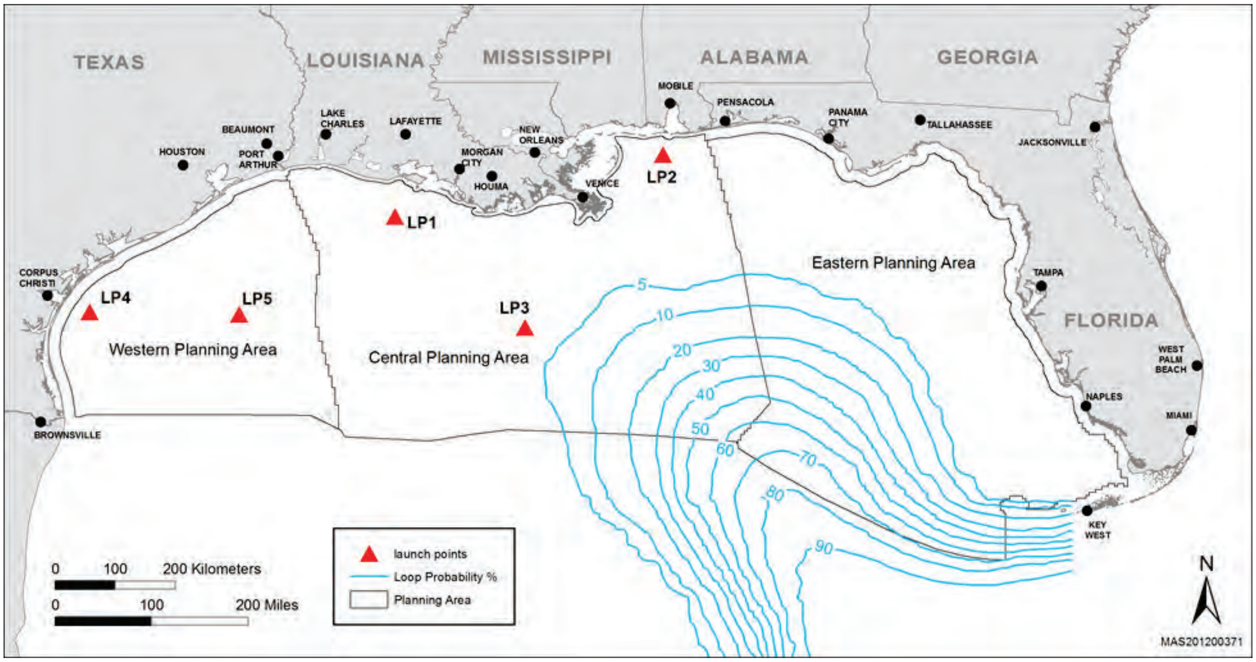

Figure C-1. Launch Point Locations Selected for Modeling the Trajectories of Five Hypothetical Oil Spills. (The blue lines show the frequency (% of time) of the watermass associated with the Loop Current occupied an area based on data for the period 1976-2003. Adapted from Vukovich, 2007.)

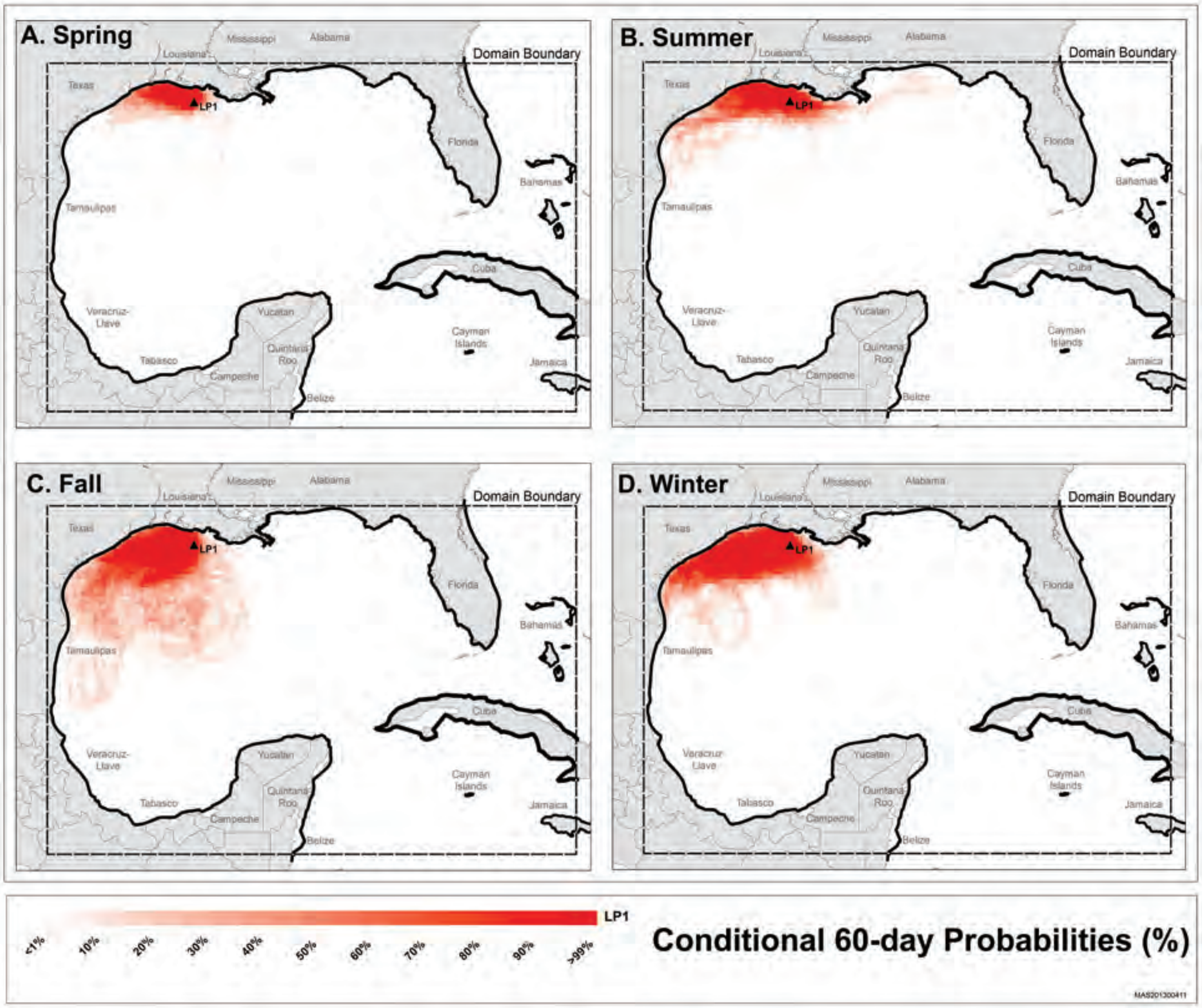

Figure C-2. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 1 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

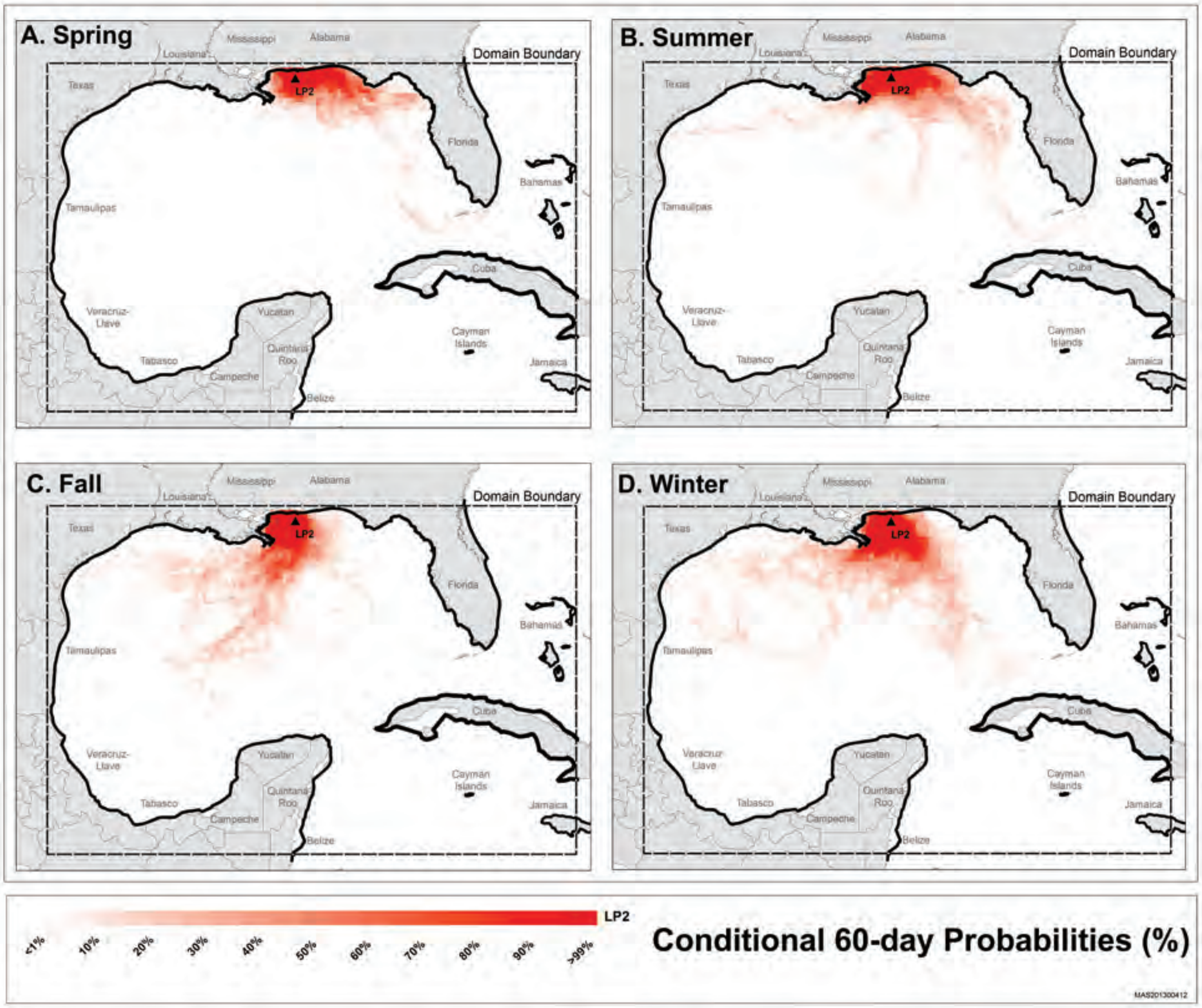

Figure C-3. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 2 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

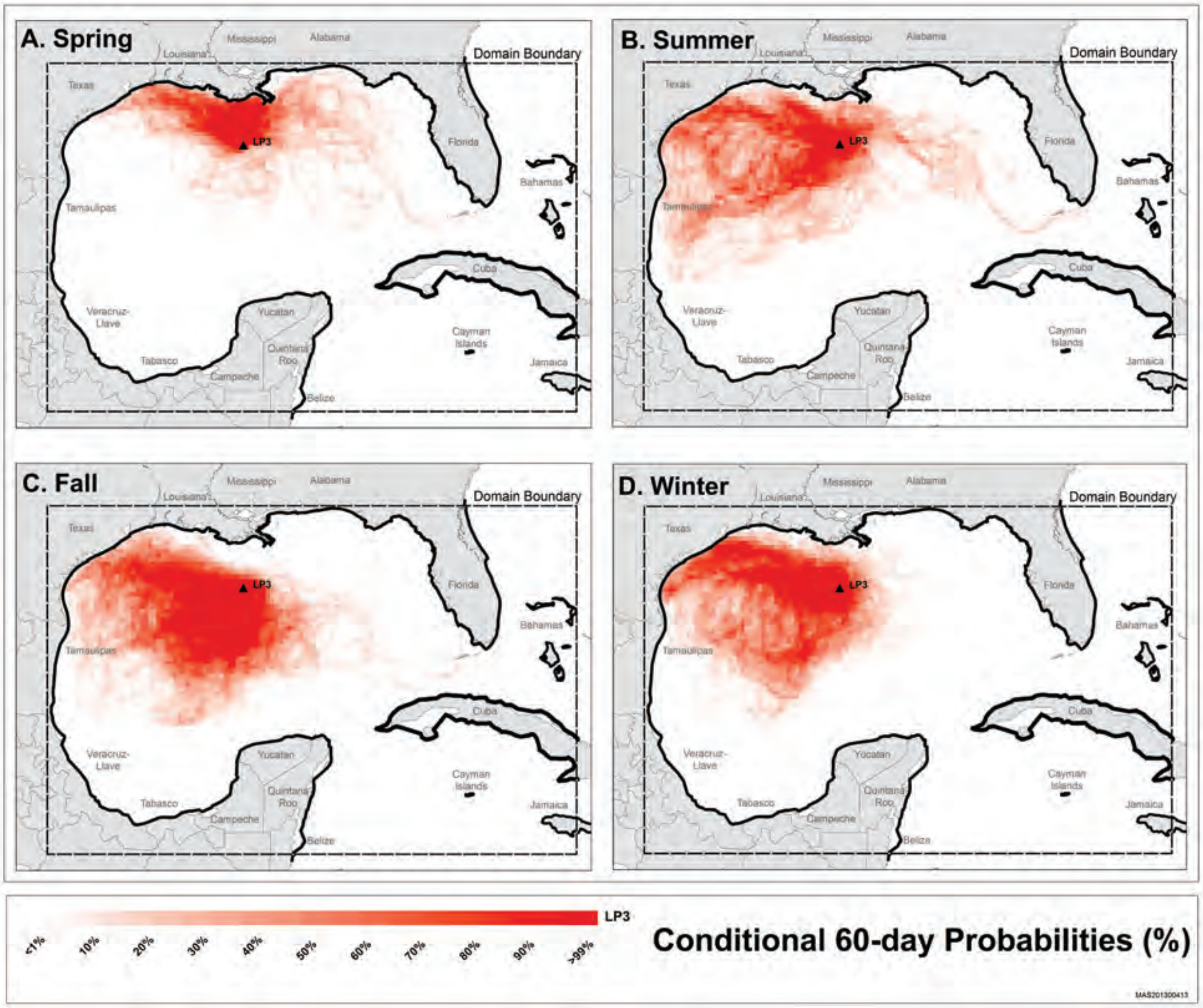

Figure C-4. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 3 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

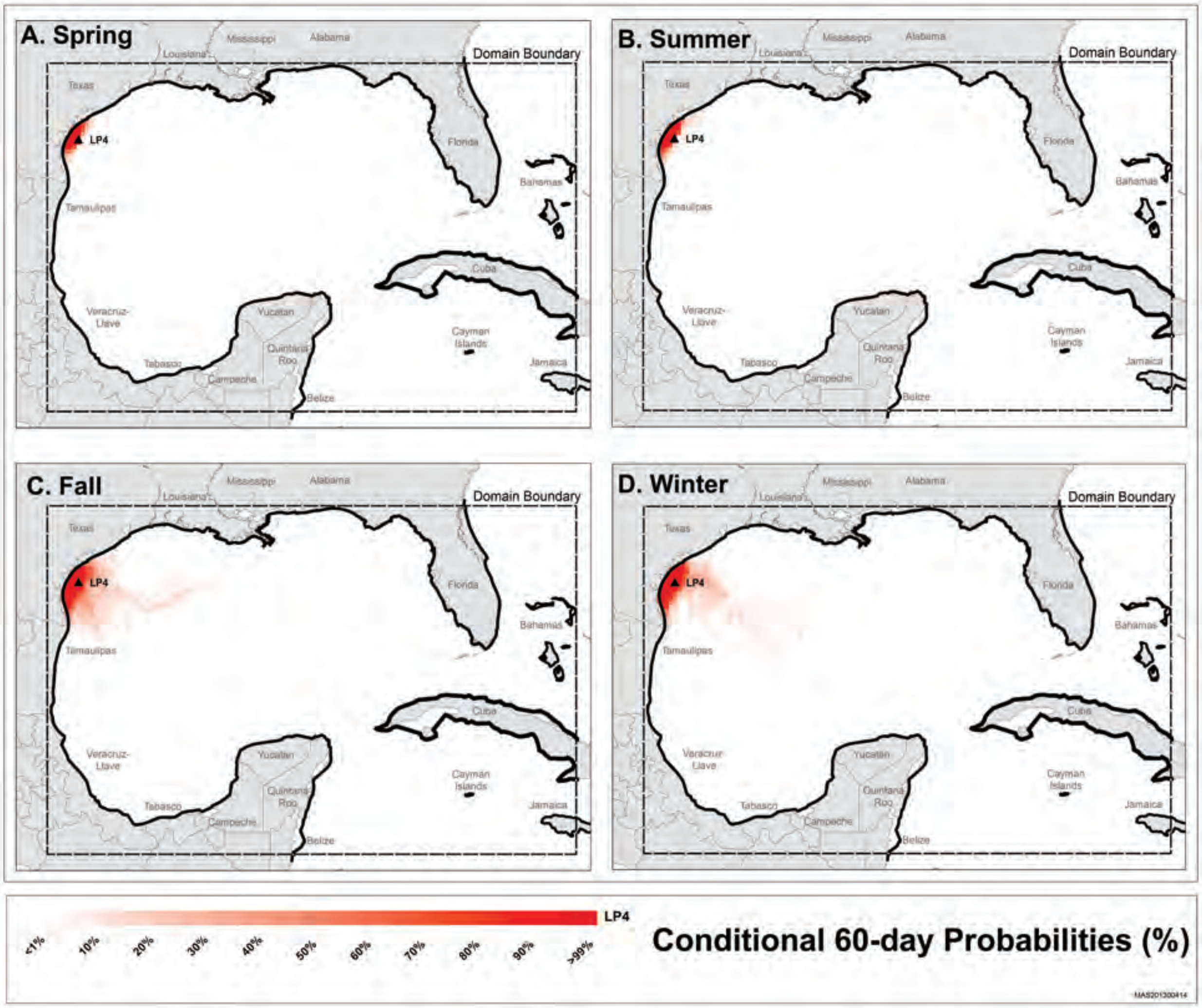

Figure C-5. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 4 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

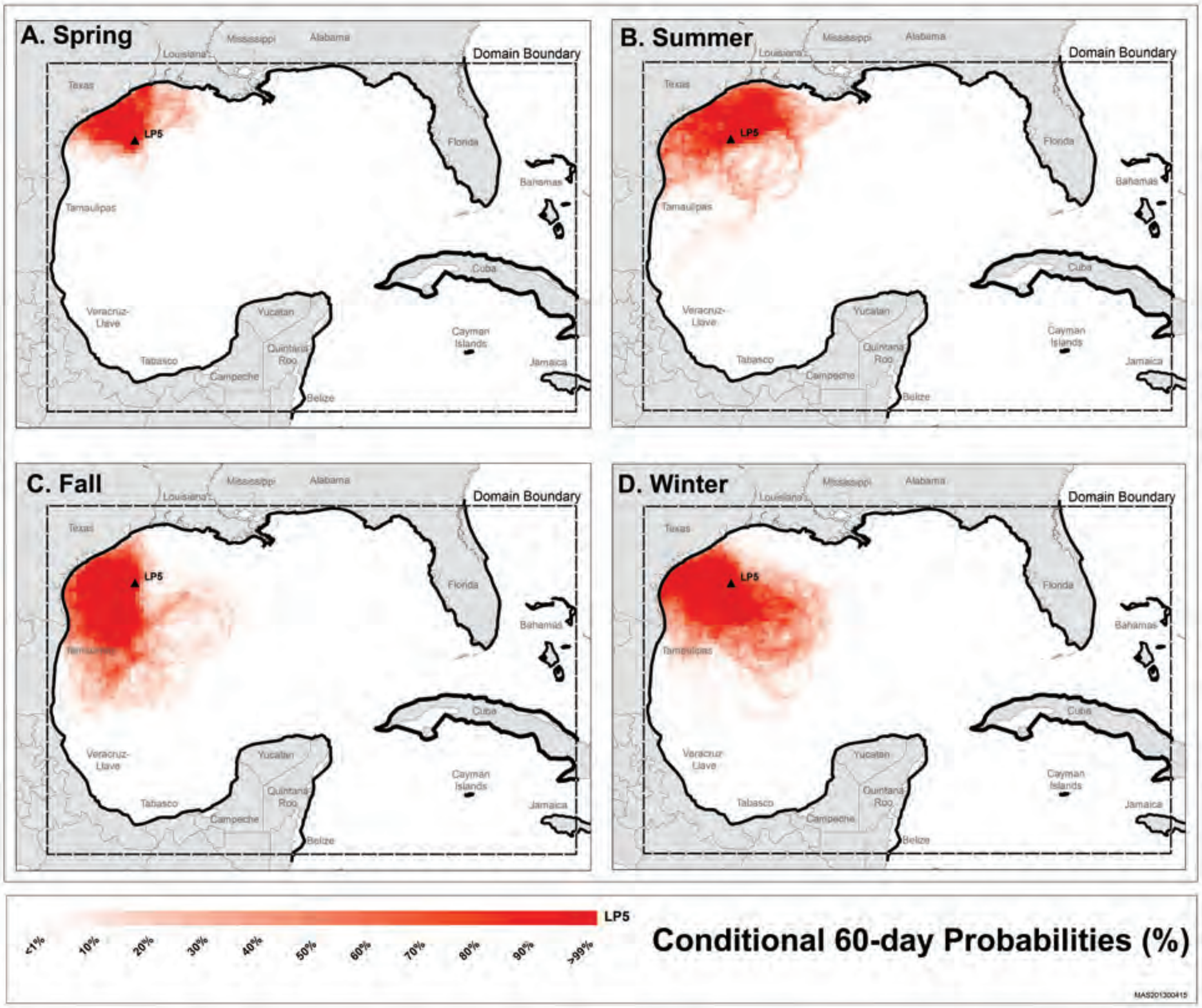

Figure C-6. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 5 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

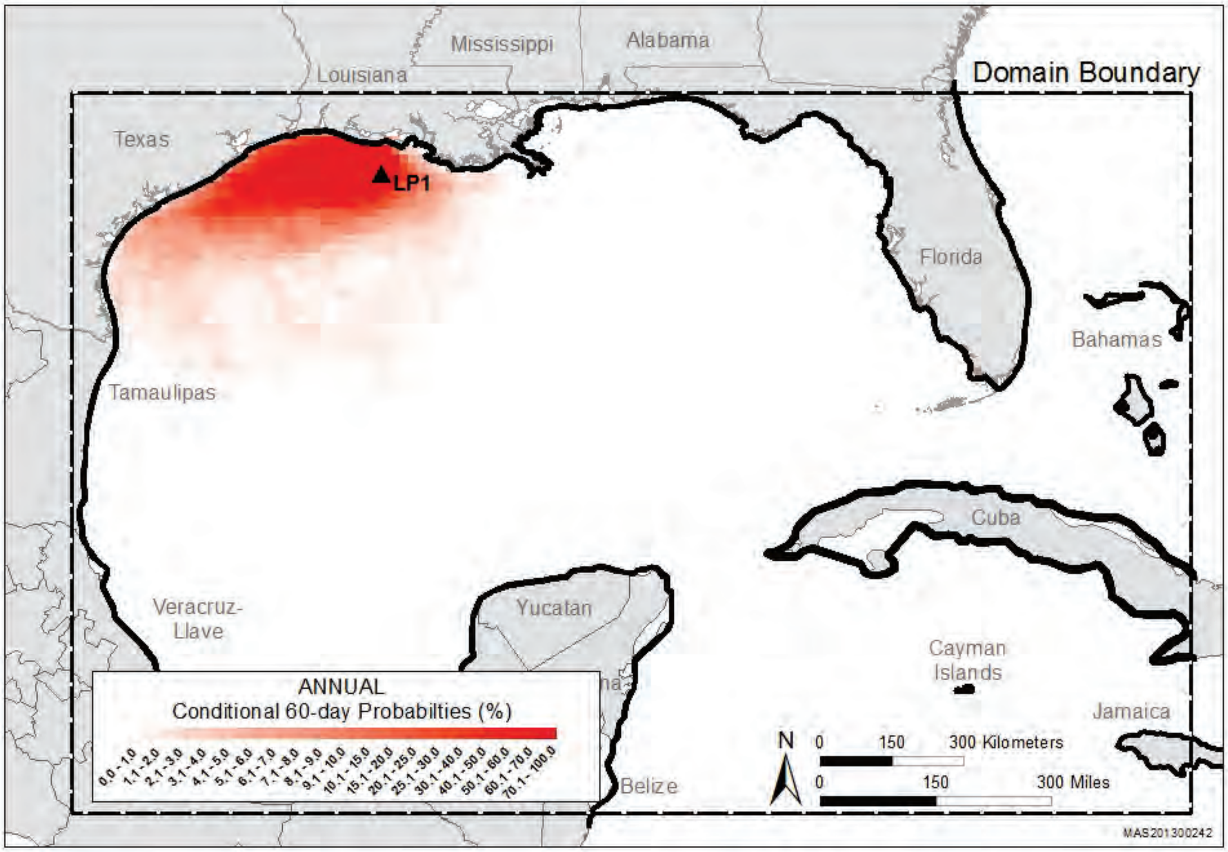

Figure C-7. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 1 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

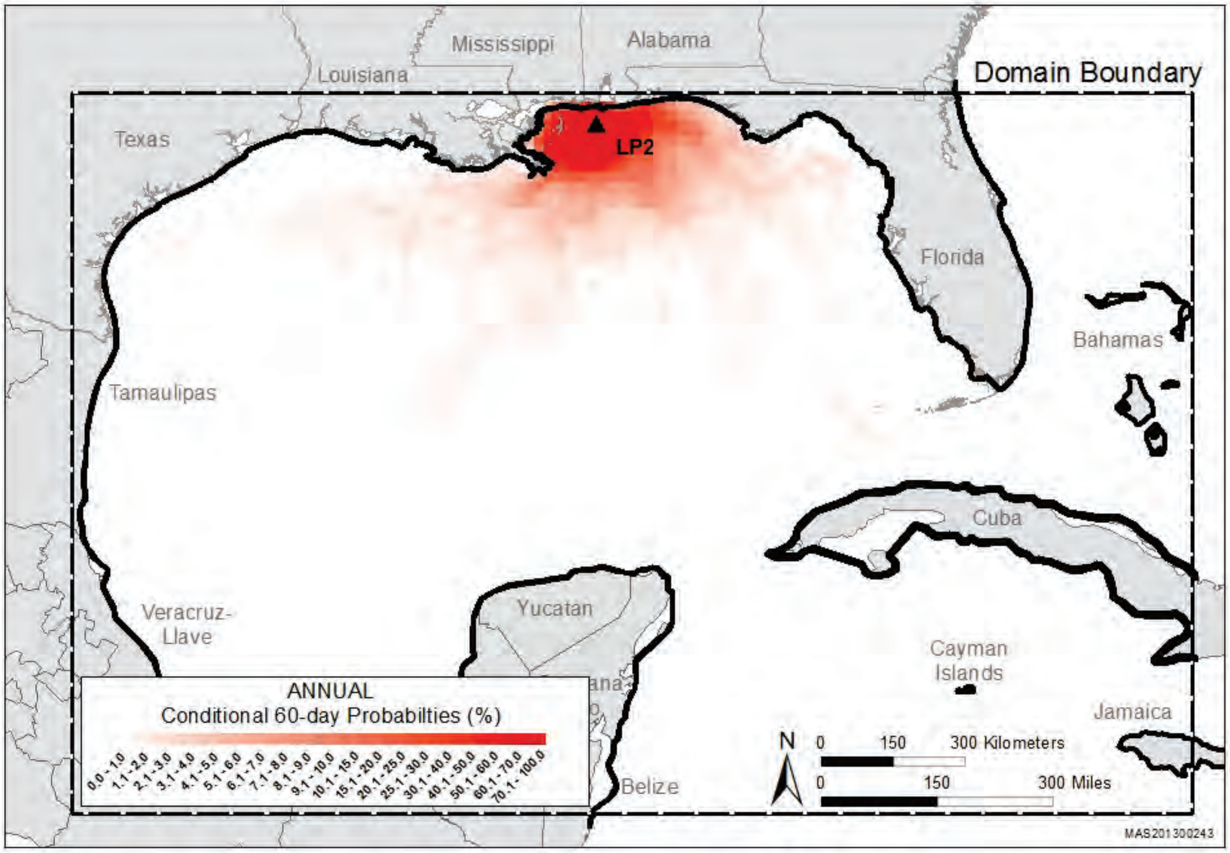

Figure C-8. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 2 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

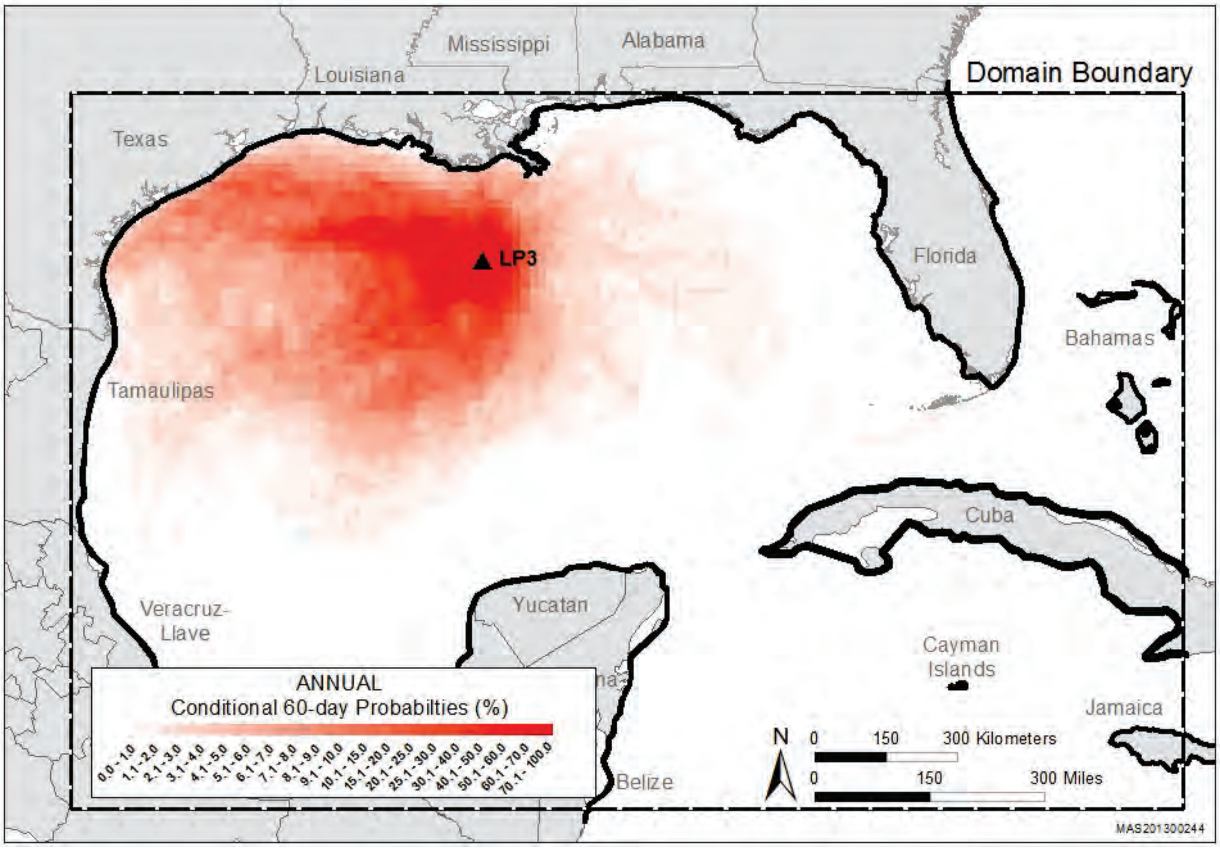

Figure C-9. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 3 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

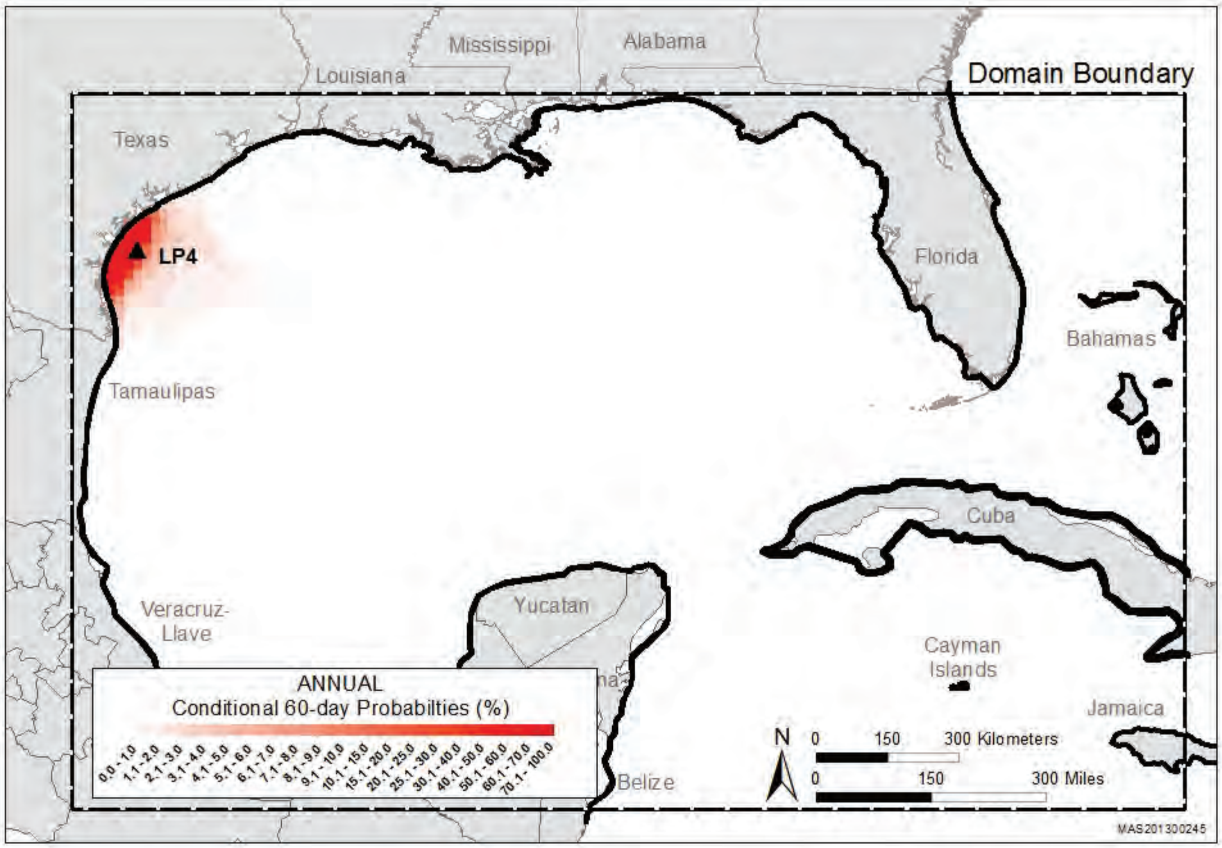

Figure C-10. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 4 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

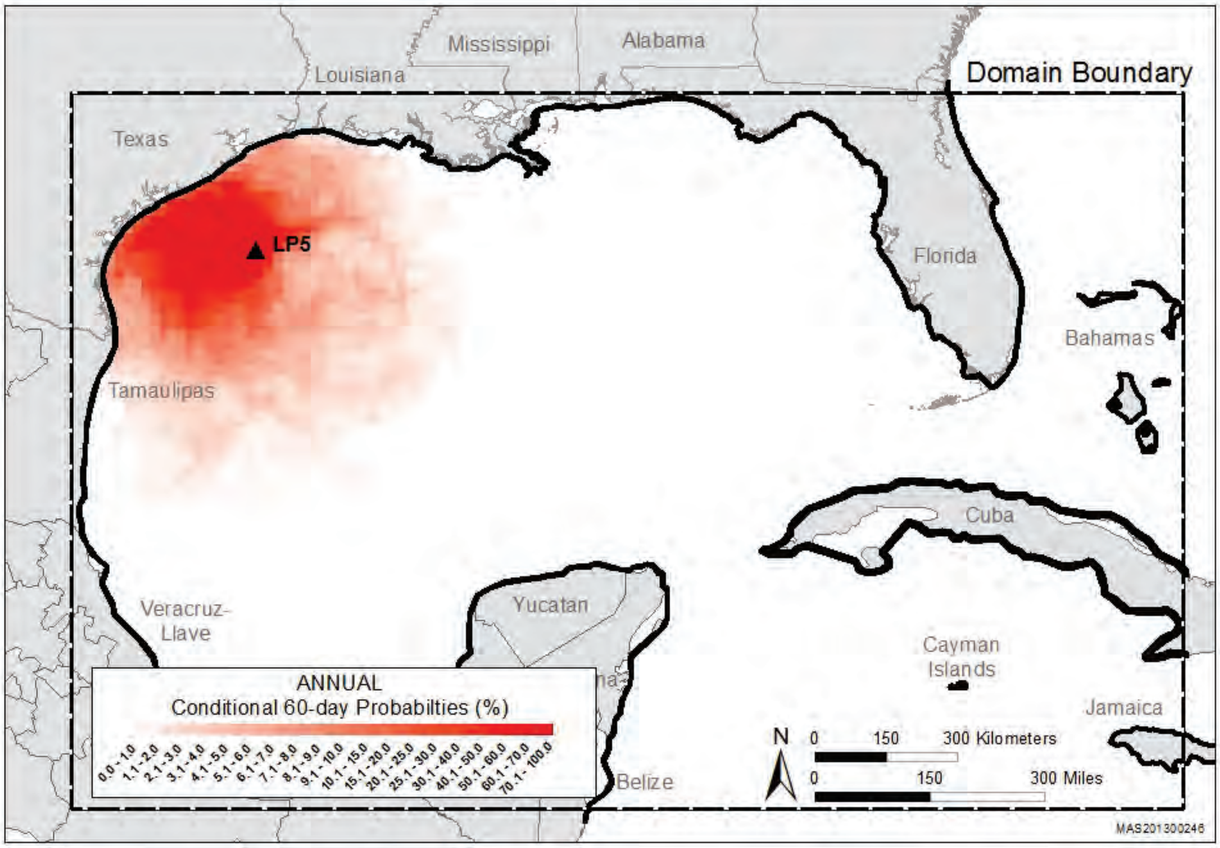

Figure C-11. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point 5 with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

Table C-1

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	1
Willacy, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1
Kenedy, TX	–	–	–	–	–	–	2	2	–	–	1	2	–	–	1	4	–	–	1	2
Kleberg, TX	–	–	–	–	–	–	1	1	–	–	1	1	–	–	1	2	–	–	1	1
Nueces, TX	–	–	–	–	–	–	1	1	–	–	1	2	–	–	1	3	–	–	1	2
Aransas, TX	–	–	–	–	–	–	1	2	–	–	2	2	–	–	1	3	–	–	1	2
Calhoun, TX	–	–	–	–	–	–	5	5	–	–	2	3	–	–	3	7	–	–	2	4
Matagorda, TX	–	–	1	1	–	1	5	6	–	1	9	9	–	–	9	14	–	1	6	7
Brazoria, TX	–	1	3	3	–	1	3	4	–	1	5	5	–	1	7	9	–	1	4	5
Galveston, TX	–	3	9	9	–	3	9	11	–	2	9	9	–	3	10	13	–	3	9	10
Chambers, TX	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, TX	–	5	10	10	–	3	8	8	–	3	6	6	–	2	5	6	–	3	7	7
Cameron, LA	8	36	42	42	1	12	21	23	2	11	13	15	2	9	11	12	3	17	22	23
Vermilion, LA	10	22	23	23	2	10	13	14	3	7	8	8	3	7	8	8	5	12	13	13
Iberia, LA	1	5	6	6	–	4	7	7	–	1	1	1	–	1	1	2	1	3	4	4
St. Mary, LA	–	1	1	1	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	1
Terrebonne, LA	–	2	3	3	1	3	6	6	–	1	2	2	–	–	2	2	–	2	3	3
Lafourche, LA	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plaquemines, LA	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–

Table C-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hancock, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Harrison, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jackson, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mobile, AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Baldwin, AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Escambia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Santa Rosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Okaloosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Walton, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bay, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Franklin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wakulla, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taylor, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dixie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Levy, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Citrus, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hernando, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pasco, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinellas, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hillsborough, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Manatee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sarasota, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Charlotte, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Collier, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monroe, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dade, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Broward, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Palm Beach, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Martin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Lucie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Indian River, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brevard, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Volusia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flagler, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Johns, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Duval, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nassau, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX	–	11	23	23	–	7	36	41	–	7	36	41	–	6	39	64	–	8	33	43
LA	19	66	76	76	5	30	49	52	6	20	25	27	5	17	22	24	9	33	43	45
MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tamaulipas, Mexico	–	–	–	–	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	1

Table C-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Veracruz-Llave, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tabasco, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campeche, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yucatan, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Quintana Roo, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Belize (country)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cuba	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Passerines	–	4	5	5	–	1	15	17	–	2	11	16	–	1	11	28	–	2	11	17
Raptors	–	10	18	18	–	4	27	30	–	6	23	28	–	5	23	43	–	6	23	30
Shorebirds	6	28	39	39	2	14	45	50	2	13	35	40	1	10	34	56	3	16	38	46
Wading Birds	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Waterfowl	19	63	75	76	5	29	62	66	6	20	39	45	5	17	38	58	9	32	53	61
Diving Birds	19	70	88	88	5	33	75	81	6	24	49	56	5	20	48	71	9	37	65	74
Gulls/Terns	19	71	90	90	5	34	77	83	6	25	53	59	5	21	51	75	9	38	68	77
Piping Plover	6	14	16	16	3	15	36	39	5	19	32	35	5	15	29	37	5	16	29	32
Sea Turtle Nesting Habitat I	–	11	23	23	–	7	24	28	–	–	–	–	–	1	9	15	–	5	14	16
Sea Turtle Nesting Habitat II	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sea Turtle Sporadic Nesting Habitat I	19	66	76	76	5	30	49	51	–	–	–	–	–	1	3	4	6	24	32	33
Sea Turtle Sporadic Nesting Habitat II	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Indian Manatee Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Indian Manatee Rare Habitat	19	77	99	99	5	37	85	92	2	9	17	17	–	2	12	19	6	31	53	57
Alabama Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Perdido Key Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Santa Rosa Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Choctawhatchee Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Andrews Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Anastasia Island Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Smalltooth Sawfish Critical Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Short Nose Sturgeon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon Critical Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX Coastal Bend Beach Area	–	–	–	–	–	–	5	7	–	–	5	9	–	–	4	16	–	–	4	8
TX Matagorda Beach Area	–	–	1	1	–	1	9	10	–	1	11	12	–	–	12	20	–	1	9	11

Table C-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	–	5	12	12	–	4	13	16	–	3	14	14	–	4	17	22	–	4	14	16
TX Sea Rim State Park	–	5	10	10	–	3	8	8	–	3	6	6	–	2	5	6	–	3	7	7
LA Beach Areas	8	36	42	42	1	12	22	24	2	11	14	15	2	9	11	13	3	17	22	23
AL/MS Gulf Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf Shores	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Panhandle Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Big Bend Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southwest Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Ten Thousand Islands Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Central East Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Northeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Gulf Coast Jaguarondi and Ocelot	–	–	–	–	–	–	5	7	–	–	5	9	–	–	4	16	–	–	4	8
Louisiana Black Bear	1	6	8	8	–	5	7	7	–	1	2	2	–	2	2	2	1	3	5	5
Northern Aplomado Falcon	–	–	–	–	–	–	–	1	–	–	1	2	–	–	1	3	–	–	–	1
Whooping Crane 1	–	–	–	–	–	–	6	6	–	–	4	5	–	–	4	10	–	–	4	5
Whooping Crane 2	10	22	23	23	2	10	13	14	3	7	8	8	3	7	8	8	5	12	13	13

Table C-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Wood Stork	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alabama Red-bellied Turtle	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gopher Tortoise and Louisiana Quillwort	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Eastern Indigo Snake	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Gopher Frog	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flatwoods Salamander	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Telephus Spurge	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Sandhill Crane	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Everglades Snail Kite	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cape Sable Seaside Sparrow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Roseate Tern	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-2

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Willacy, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kenedy, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Kleberg, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nueces, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Aransas, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Calhoun, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Matagorda, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Brazoria, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Galveston, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chambers, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cameron, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vermilion, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Iberia, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Mary, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Terrebonne, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	2	2	–	–	1	1
Lafourche, LA	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	1	–	–	–	–
Jefferson, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
Plaquemines, LA	–	2	3	3	2	9	17	19	2	17	24	24	1	12	18	20	1	10	15	17

Table C-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	–	5	6	6	1	8	13	14	1	8	10	10	1	5	8	8	1	7	9	10
Hancock, MS	–	2	3	3	–	2	2	2	1	2	3	3	–	1	2	3	–	2	3	3
Harrison, MS	2	5	5	5	1	4	5	5	1	2	3	3	2	3	4	4	1	3	4	4
Jackson, MS	7	13	14	14	3	6	8	8	6	11	12	13	6	10	12	13	6	10	11	12
Mobile, AL	13	18	19	19	4	9	10	10	8	12	12	13	9	12	13	13	9	13	14	14
Baldwin, AL	8	15	18	18	2	8	9	9	1	2	3	3	3	6	7	7	3	8	9	9
Escambia, FL	1	6	9	10	1	4	6	6	–	1	1	1	–	2	2	3	–	3	5	5
Santa Rosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Okaloosa, FL	–	1	2	2	–	1	2	2	–	–	–	–	–	–	–	–	–	–	1	1
Walton, FL	–	–	1	1	–	1	1	1	–	–	–	1	–	–	–	–	–	–	1	1
Bay, FL	–	2	3	3	–	1	2	3	–	–	–	–	–	–	–	1	–	1	1	2
Gulf, FL	–	1	3	4	–	–	2	2	–	–	–	–	–	–	–	–	–	–	1	1
Franklin, FL	–	–	1	2	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	1
Wakulla, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taylor, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dixie, FL	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Levy, FL	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Citrus, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hernando, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pasco, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinellas, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hillsborough, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Manatee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sarasota, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Charlotte, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Collier, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monroe, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dade, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Broward, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Palm Beach, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Martin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Lucie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Indian River, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brevard, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Volusia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flagler, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Johns, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Duval, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nassau, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	2	–	–	–	1
LA	–	6	8	9	3	17	30	35	3	25	36	36	2	18	29	33	2	17	26	28
MS	9	20	22	22	5	12	15	15	8	15	18	19	8	15	18	20	7	15	18	19
AL	21	33	37	37	6	17	20	20	9	14	15	15	12	18	20	20	12	20	23	23
FL	1	11	19	26	1	7	14	16	–	1	3	3	–	2	4	5	1	5	10	13
Tamaulipas, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Veracruz-Llave, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tabasco, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campeche, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yucatan, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Quintana Roo, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Belize (country)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cuba	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Passerines	28	53	61	62	12	33	42	45	17	31	37	39	19	33	39	44	19	38	45	48
Raptors	22	37	42	46	7	17	24	26	13	19	22	23	15	22	24	27	14	24	28	31
Shorebirds	23	44	53	58	8	24	34	38	13	23	28	30	15	26	33	39	15	29	37	41
Wading Birds	27	48	54	55	11	28	36	37	17	30	34	36	19	31	36	40	18	34	40	42
Waterfowl	19	37	43	45	9	33	50	56	13	41	54	56	13	35	48	56	14	36	49	53
Diving Birds	31	60	67	68	14	46	65	72	20	54	69	72	22	50	66	75	22	52	67	72
Gulls/Terns	31	61	72	76	13	36	52	58	19	42	55	58	22	43	57	67	21	46	59	65
Piping Plover	11	18	20	20	7	23	32	35	17	31	39	42	19	32	41	46	14	26	33	36
Sea Turtle Nesting Habitat I	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Sea Turtle Nesting Habitat II	32	64	77	83	12	35	48	51	11	19	20	21	1	3	4	8	14	30	37	41
Sea Turtle Sporadic Nesting Habitat I	–	–	1	1	–	–	–	1	–	–	–	–	–	–	1	2	–	–	1	1
Sea Turtle Sporadic Nesting Habitat II	–	6	9	10	3	17	29	33	2	18	24	24	–	1	4	4	2	11	17	18

Table C-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Habitat	1	11	19	26	1	7	14	16	–	1	3	3	–	2	4	5	1	5	10	13
West Indian Manatee Sporadic Habitat	31	58	65	66	13	38	50	52	5	13	14	14	1	3	5	8	12	28	34	35
West Indian Manatee Rare Habitat	–	2	2	3	2	8	15	19	1	6	6	6	–	1	3	5	1	4	7	8
Alabama Beach Mouse	8	15	18	18	2	8	9	9	1	2	3	3	3	6	7	7	3	8	9	9
Perdido Key Beach Mouse	9	21	27	28	3	12	15	16	1	3	4	4	3	7	9	10	4	11	14	15
Santa Rosa Beach Mouse	–	3	5	6	–	3	4	5	–	1	1	1	–	1	2	2	–	2	3	3
Choctawhatchee Beach Mouse	–	3	6	7	–	2	5	6	–	–	1	1	–	1	1	1	–	2	3	4
St. Andrews Beach Mouse	–	3	5	7	–	1	4	5	–	–	–	–	–	–	–	1	–	1	2	3
Southeastern Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Anastasia Island Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Smalltooth Sawfish Critical Habitat	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Short Nose Sturgeon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon Critical Habitat	32	69	83	89	13	44	62	65	18	40	47	48	21	40	49	54	21	48	60	64
Gulf Sturgeon	32	70	86	92	15	52	78	83	20	55	68	70	22	51	65	71	22	57	74	79
TX Coastal Bend Beach Area	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1

Table C-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Matagorda Beach Area	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
TX Galveston Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
TX Sea Rim State Park	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Beach Areas	–	–	–	–	–	–	–	1	–	–	1	1	–	–	1	2	–	–	1	1
AL/MS Gulf Islands	23	38	41	41	9	21	25	26	16	27	30	32	17	27	30	33	16	28	32	33
AL Gulf Shores	8	15	18	18	2	8	9	9	1	2	3	3	3	6	7	7	3	8	9	9
FL Panhandle Beach Area	1	11	18	23	1	7	14	15	–	1	3	3	–	2	4	5	1	5	10	11
FL Big Bend Beach Area	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
FL Southwest Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Ten Thousand Islands Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southeast Beach Area	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
FL Central East Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Northeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Gulf Coast Jaguarondi and Ocelot	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
Louisiana Black Bear	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern Aplomado Falcon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane 1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Whooping Crane 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Wood Stork	22	44	56	63	7	24	34	36	9	15	18	18	12	20	23	25	13	26	33	36
Alabama Red-bellied Turtle	30	51	56	57	11	27	32	33	16	27	30	31	20	31	35	37	19	34	38	39
Gopher Tortoise and Louisiana Quillwort	9	20	22	22	5	12	15	15	8	15	18	19	8	15	18	20	7	15	18	19
Eastern Indigo Snake	1	11	19	26	1	7	14	16	–	1	3	3	–	2	4	5	1	5	10	13
Mississippi Gopher Frog	9	18	19	19	4	10	13	13	7	13	15	16	8	13	16	17	7	14	16	16
Flatwoods Salamander	–	–	1	2	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	1
Telephus Spurge	–	3	6	9	–	1	5	5	–	–	–	–	–	–	–	1	–	1	3	4
Mississippi Sandhill Crane	9	18	19	19	4	10	13	13	7	13	15	16	8	13	16	17	7	14	16	16
Everglades Snail Kite	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Cape Sable Seaside Sparrow	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Roseate Tern	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-3

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	–	–	–	–	–	–	–	2	–	–	–	1	–	–	–	1	–	–	–	1
Willacy, TX	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	2	–	–	–	1
Kenedy, TX	–	–	–	–	–	–	1	5	–	–	–	2	–	–	–	3	–	–	–	3
Kleberg, TX	–	–	–	–	–	–	1	3	–	–	1	2	–	–	–	2	–	–	–	2
Nueces, TX	–	–	–	–	–	–	–	2	–	–	1	2	–	–	–	3	–	–	–	1
Aransas, TX	–	–	–	–	–	–	–	2	–	–	1	2	–	–	–	3	–	–	–	2
Calhoun, TX	–	–	–	–	–	–	–	3	–	–	1	2	–	–	1	4	–	–	1	2
Matagorda, TX	–	–	3	5	–	–	1	4	–	–	2	5	–	–	3	10	–	–	2	6
Brazoria, TX	–	–	3	3	–	–	2	5	–	–	1	2	–	–	3	8	–	–	2	5
Galveston, TX	–	–	3	5	–	–	2	3	–	–	1	2	–	–	2	5	–	–	2	4
Chambers, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, TX	–	–	4	5	–	–	1	1	–	–	–	–	–	–	1	2	–	–	1	2
Cameron, LA	–	–	9	11	–	–	1	3	–	–	–	2	–	–	1	3	–	–	3	5
Vermilion, LA	–	1	5	6	–	–	1	1	–	–	–	–	–	–	1	2	–	–	2	2
Iberia, LA	–	1	3	3	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1
St. Mary, LA	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Terrebonne, LA	–	5	12	13	–	–	1	2	–	–	1	1	–	1	2	2	–	2	4	5
Lafourche, LA	–	2	5	6	–	–	1	2	–	–	–	–	–	–	1	2	–	1	2	2
Jefferson, LA	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1
Plaquemines, LA	–	3	10	10	–	–	2	3	–	–	–	–	–	–	2	2	–	1	3	4

Table C-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hancock, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Harrison, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jackson, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mobile, AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Baldwin, AL	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Escambia, FL	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Santa Rosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Okaloosa, FL	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Walton, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bay, FL	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Franklin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wakulla, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taylor, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dixie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Levy, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Citrus, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hernando, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pasco, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinellas, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hillsborough, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Manatee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sarasota, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Charlotte, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Collier, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monroe, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dade, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Broward, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Palm Beach, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Martin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Lucie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Indian River, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brevard, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Volusia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flagler, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Johns, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Duval, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nassau, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX	–	–	13	19	–	–	7	30	–	–	7	21	–	–	11	44	–	–	10	28
LA	–	12	46	52	–	2	6	12	–	1	2	4	–	2	8	12	–	4	16	20
MS	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
AL	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL	–	–	2	5	–	–	–	2	–	–	–	–	–	–	–	1	–	–	1	2
Tamaulipas, Mexico	–	–	–	–	–	–	–	4	–	–	–	3	–	–	–	1	–	–	–	2

Table C-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Veracruz-Llave, Mexico	–	–	–	–	–	–	–	2	–	–	–	2	–	–	–	–	–	–	–	1
Tabasco, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campeche, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yucatan, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Quintana Roo, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Belize (country)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cuba	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Passerines	–	–	5	7	–	–	3	21	–	–	5	14	–	–	3	23	–	–	4	16
Raptors	–	–	10	15	–	–	6	25	–	–	6	16	–	–	5	29	–	–	7	21
Shorebirds	–	8	36	44	–	1	10	34	–	1	8	19	–	1	11	40	–	3	16	35
Wading Birds	–	–	1	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Waterfowl	–	12	49	57	–	2	11	35	–	1	8	20	–	2	12	38	–	4	20	38
Diving Birds	–	12	56	66	–	2	12	39	–	1	8	21	–	2	15	47	–	4	23	43
Gulls/Terns	–	13	58	69	–	2	13	41	–	1	8	22	–	2	16	50	–	4	24	46
Piping Plover	–	2	4	6	–	1	6	16	–	1	5	10	–	1	8	18	–	1	6	12
Sea Turtle Nesting Habitat I	–	–	13	19	–	–	3	11	–	–	–	–	–	–	7	24	–	–	6	13
Sea Turtle Nesting Habitat II	–	–	3	7	–	–	1	3	–	–	–	–	–	–	–	1	–	–	1	3
Sea Turtle Sporadic Nesting Habitat I	–	11	43	48	–	1	6	10	–	–	–	–	–	–	3	7	–	3	13	16
Sea Turtle Sporadic Nesting Habitat II	–	1	3	4	–	–	1	2	–	–	–	–	–	–	–	–	–	–	1	2
West Indian Manatee Habitat	–	–	2	5	–	–	–	2	–	–	–	–	–	–	–	1	–	–	1	2

Table C-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	–	–	2	3	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1
West Indian Manatee Rare Habitat	–	12	59	70	–	2	13	36	–	–	2	2	–	–	11	30	–	4	21	34
Alabama Beach Mouse	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Perdido Key Beach Mouse	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Santa Rosa Beach Mouse	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Choctawhatchee Beach Mouse	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
St. Andrews Beach Mouse	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern Beach Mouse	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Anastasia Island Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Smalltooth Sawfish Critical Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Short Nose Sturgeon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon Critical Habitat	–	–	4	7	–	–	1	2	–	–	–	–	–	–	–	–	–	–	1	2
Gulf Sturgeon	–	1	6	10	–	–	1	3	–	–	–	–	–	–	1	1	–	–	2	3
TX Coastal Bend Beach Area	–	–	–	–	–	–	2	14	–	–	3	10	–	–	1	14	–	–	2	10
TX Matagorda Beach Area	–	–	3	5	–	–	1	7	–	–	3	7	–	–	3	15	–	–	3	8

Table C-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	–	–	6	9	–	–	3	8	–	–	1	5	–	–	5	13	–	–	4	8
TX Sea Rim State Park	–	–	4	5	–	–	1	1	–	–	–	–	–	–	1	2	–	–	1	2
LA Beach Areas	–	3	15	18	–	1	3	5	–	–	1	3	–	–	2	5	–	1	5	8
AL/MS Gulf Islands	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf Shores	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Panhandle Beach Area	–	–	2	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
FL Big Bend Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southwest Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Ten Thousand Islands Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southeast Beach Area	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
FL Central East Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Northeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Gulf Coast Jaguarondi and Ocelot	–	–	–	–	–	–	2	14	–	–	3	10	–	–	1	14	–	–	2	10
Louisiana Black Bear	–	1	4	4	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1
Northern Aplomado Falcon	–	–	–	–	–	–	–	2	–	–	–	2	–	–	–	3	–	–	–	2
Whooping Crane 1	–	–	–	–	–	–	1	5	–	–	2	4	–	–	1	7	–	–	1	4
Whooping Crane 2	–	1	5	6	–	–	1	1	–	–	–	–	–	–	1	2	–	–	2	2

Table C-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Wood Stork	–	–	3	7	–	–	1	2	–	–	–	–	–	–	–	1	–	–	1	3
Alabama Red-bellied Turtle	–	–	1	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Gopher Tortoise and Louisiana Quillwort	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Eastern Indigo Snake	–	–	2	5	–	–	–	2	–	–	–	–	–	–	–	1	–	–	1	2
Mississippi Gopher Frog	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flatwoods Salamander	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Telephus Spurge	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Sandhill Crane	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Everglades Snail Kite	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
Cape Sable Seaside Sparrow	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Roseate Tern	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-4

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	–	–	–	–	–	–	–	–	–	2	2	2	1	2	2	2	–	1	1	1
Willacy, TX	1	1	1	1	–	1	1	1	2	5	6	6	2	3	3	3	1	2	3	3
Kenedy, TX	5	7	7	7	5	9	9	9	10	22	23	24	10	22	23	23	8	15	16	16
Kleberg, TX	8	11	11	11	8	13	13	13	7	12	12	12	9	14	14	14	8	12	13	13
Nueces, TX	23	27	27	27	12	19	19	19	13	18	19	19	12	19	20	20	15	21	21	21
Aransas, TX	33	36	36	36	18	26	26	26	10	13	14	14	10	16	17	17	18	23	23	23
Calhoun, TX	11	14	14	14	15	22	23	23	7	11	12	13	5	10	11	11	10	14	15	15
Matagorda, TX	1	2	2	2	1	4	5	5	–	1	2	2	–	2	2	2	1	2	3	3
Brazoria, TX	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–
Galveston, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chambers, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cameron, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vermilion, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Iberia, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Mary, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Terrebonne, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lafourche, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plaquemines, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hancock, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Harrison, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jackson, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mobile, AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Baldwin, AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Escambia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Santa Rosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Okaloosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Walton, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bay, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Franklin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wakulla, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taylor, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dixie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Levy, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Citrus, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hernando, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pasco, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinellas, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hillsborough, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Manatee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sarasota, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Charlotte, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Collier, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monroe, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dade, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Broward, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Palm Beach, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Martin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Lucie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Indian River, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brevard, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Volusia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flagler, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Johns, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Duval, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nassau, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX	82	97	97	98	58	94	96	96	49	84	92	93	48	87	93	93	60	91	95	95
LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tamaulipas, Mexico	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–

Table C-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Veracruz-Llave, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tabasco, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campeche, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yucatan, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Quintana Roo, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Belize (country)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cuba	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Passerines	82	96	97	97	58	91	93	93	49	83	90	91	48	87	91	92	59	89	93	93
Raptors	82	96	97	97	58	92	93	93	49	84	91	91	48	87	92	92	59	90	93	94
Shorebirds	82	96	97	97	58	92	94	94	49	84	91	92	48	87	92	93	59	90	93	94
Wading Birds	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Waterfowl	82	96	97	97	58	92	93	93	49	84	91	91	48	87	92	92	59	90	93	94
Diving Birds	82	96	97	97	58	92	94	94	49	84	91	92	48	87	92	93	59	90	93	94
Gulls/Terns	82	96	97	97	58	92	94	94	49	84	92	92	48	87	92	93	59	90	94	94
Piping Plover	9	11	11	11	12	22	23	23	14	23	26	26	14	24	25	25	12	20	21	21
Sea Turtle Nesting Habitat I	82	97	97	98	56	89	90	90	–	–	–	–	2	3	3	3	35	47	48	48
Sea Turtle Nesting Habitat II	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sea Turtle Sporadic Nesting Habitat I	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sea Turtle Sporadic Nesting Habitat II	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Indian Manatee Sporadic Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Indian Manatee Rare Habitat	82	97	97	98	58	94	96	96	21	28	28	28	2	3	3	3	41	56	56	56
Alabama Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Perdido Key Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Santa Rosa Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Choctawhatchee Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Andrews Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Anastasia Island Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Smalltooth Sawfish Critical Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Short Nose Sturgeon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon Critical Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX Coastal Bend Beach Area	71	81	81	82	43	67	68	68	42	72	77	77	42	75	79	79	49	74	76	76

Table C-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Matagorda Beach Area	12	16	16	16	16	27	28	28	7	12	14	15	6	12	13	13	10	17	18	18
TX Galveston Beach Area	–	–	–	–	–	1	1	1	–	–	1	1	–	–	1	1	–	–	1	1
TX Sea Rim State Park	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Beach Areas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL/MS Gulf Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf Shores	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Panhandle Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Big Bend Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southwest Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Ten Thousand Islands Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Central East Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Northeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Gulf Coast Jaguarondi and Ocelot	71	81	81	82	43	67	68	68	42	72	77	77	42	75	79	79	49	74	76	76
Louisiana Black Bear	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northern Aplomado Falcon	1	1	1	1	–	1	1	1	3	7	8	8	2	5	5	5	1	3	4	4

Table C-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane 1	10	12	12	12	5	8	9	9	17	24	27	27	15	26	28	28	12	18	19	19
Whooping Crane 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wood Stork	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alabama Red-bellied Turtle	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gopher Tortoise and Louisiana Quillwort	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Eastern Indigo Snake	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Gopher Frog	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flatwoods Salamander	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Telephus Spurge	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Sandhill Crane	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Everglades Snail Kite	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cape Sable Seaside Sparrow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Roseate Tern	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-5

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	–	–	–	–	–	–	2	3	–	1	5	6	–	–	3	4	–	–	2	3
Willacy, TX	–	–	–	–	–	–	2	3	–	–	3	3	–	–	2	3	–	–	2	2
Kenedy, TX	–	–	–	–	–	–	3	8	–	1	7	9	–	1	9	12	–	1	5	7
Kleberg, TX	–	1	1	1	–	–	2	3	–	1	4	4	–	–	5	6	–	–	3	3
Nueces, TX	–	1	2	2	–	–	1	2	–	1	4	4	–	1	5	6	–	1	3	4
Aransas, TX	–	1	3	3	–	–	2	3	–	1	4	5	–	1	7	8	–	1	4	5
Calhoun, TX	–	5	10	10	–	–	5	7	–	2	6	7	–	2	10	13	–	2	8	9
Matagorda, TX	–	17	28	28	–	1	9	13	–	3	9	11	–	3	12	15	–	6	14	17
Brazoria, TX	–	8	13	13	–	1	6	9	–	1	3	4	–	1	3	5	–	3	6	8
Galveston, TX	–	5	16	17	–	1	7	11	–	1	2	2	–	1	2	3	–	2	7	8
Chambers, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, TX	–	–	10	11	–	–	2	4	–	–	–	1	–	–	–	1	–	–	3	4
Cameron, LA	–	1	5	5	–	–	4	6	–	–	–	–	–	–	–	–	–	–	2	3
Vermilion, LA	–	–	1	2	–	–	1	2	–	–	–	–	–	–	–	–	–	–	1	1
Iberia, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
St. Mary, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Terrebonne, LA	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Lafourche, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plaquemines, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–

Table C-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hancock, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Harrison, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jackson, MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mobile, AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Baldwin, AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Escambia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Santa Rosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Okaloosa, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Walton, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bay, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Franklin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wakulla, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jefferson, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taylor, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dixie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Levy, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Citrus, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hernando, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pasco, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinellas, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hillsborough, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Manatee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sarasota, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Charlotte, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lee, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Collier, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monroe, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dade, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Broward, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Palm Beach, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Martin, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Lucie, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Indian River, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brevard, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Volusia, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flagler, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Johns, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Duval, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nassau, FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX	–	39	84	88	–	5	40	66	–	12	47	55	–	9	58	76	–	16	57	71
LA	–	1	7	8	–	–	7	11	–	–	–	–	–	–	–	–	–	–	3	5
MS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tamaulipas, Mexico	–	–	–	–	–	–	2	5	–	–	2	5	–	–	2	4	–	–	2	4

Table C-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Veracruz-Llave, Mexico	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Tabasco, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campeche, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yucatan, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Quintana Roo, Mexico	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Belize (country)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cuba	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Passerines	–	12	23	24	–	2	20	33	–	8	36	41	–	6	45	58	–	7	31	39
Raptors	–	18	46	49	–	3	28	46	–	9	39	45	–	6	48	62	–	9	40	50
Shorebirds	–	25	58	61	–	4	33	54	–	9	41	48	–	8	51	66	–	11	46	57
Wading Birds	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Waterfowl	–	19	44	46	–	3	33	51	–	9	39	45	–	6	48	62	–	9	41	51
Diving Birds	–	27	64	67	–	4	39	63	–	10	42	49	–	8	52	67	–	12	49	62
Gulls/Terns	–	31	73	77	–	4	41	68	–	10	43	51	–	9	54	71	–	14	53	66
Piping Plover	–	4	7	7	–	2	15	24	–	3	14	16	–	4	19	24	–	3	14	18
Sea Turtle Nesting Habitat I	–	39	84	88	–	4	30	45	–	–	–	–	–	3	15	23	–	12	32	39
Sea Turtle Nesting Habitat II	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sea Turtle Sporadic Nesting Habitat I	–	1	7	8	–	–	7	10	–	–	–	–	–	–	–	–	–	–	3	4
Sea Turtle Sporadic Nesting Habitat II	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Indian Manatee Sporadic Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Indian Manatee Rare Habitat	–	40	90	95	–	5	47	74	–	5	13	13	–	3	15	23	–	13	41	51
Alabama Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Perdido Key Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Santa Rosa Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Choctawhatchee Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
St. Andrews Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Anastasia Island Beach Mouse	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Smalltooth Sawfish Critical Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Short Nose Sturgeon	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon Critical Habitat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gulf Sturgeon	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
TX Coastal Bend Beach Area	–	4	7	7	–	1	12	22	–	4	27	31	–	3	31	40	–	3	19	25

Table C-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Matagorda Beach Area	–	22	38	38	–	1	14	20	–	5	15	17	–	5	22	28	–	8	22	26
TX Galveston Beach Area	–	13	30	31	–	2	13	20	–	2	6	6	–	2	5	8	–	5	13	16
TX Sea Rim State Park	–	–	10	11	–	–	2	4	–	–	–	1	–	–	–	1	–	–	3	4
LA Beach Areas	–	1	5	6	–	–	4	6	–	–	–	–	–	–	–	–	–	–	2	3
AL/MS Gulf Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf Shores	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Panhandle Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Big Bend Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southwest Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Ten Thousand Islands Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Southeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Central East Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Northeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Gulf Coast Jaguarondi and Ocelot	–	4	7	7	–	1	12	22	–	4	27	31	–	3	31	40	–	3	19	25
Louisiana Black Bear	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Northern Aplomado Falcon	–	–	–	–	–	–	3	5	–	1	7	9	–	–	5	8	–	–	4	6

Table C-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane 1	–	3	4	4	–	1	7	10	–	3	10	11	–	3	16	20	–	2	9	11
Whooping Crane 2	–	–	1	2	–	–	1	2	–	–	–	–	–	–	–	–	–	–	1	1
Wood Stork	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alabama Red-bellied Turtle	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gopher Tortoise and Louisiana Quillwort	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Eastern Indigo Snake	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Gopher Frog	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flatwoods Salamander	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Telephus Spurge	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Sandhill Crane	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Everglades Snail Kite	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cape Sable Seaside Sparrow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Roseate Tern	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-6

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jamaica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX State Waters	–	13	24	24	–	10	38	43	–	10	39	43	–	10	44	67	–	11	36	44
West LA State Waters	26	72	80	80	7	35	55	57	8	25	30	33	9	22	27	29	13	38	48	50
East LA State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Panhandle State Waters	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
West FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mexican Waters	–	–	–	–	–	–	1	1	–	–	–	3	–	–	–	1	–	–	–	1

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	–	–	–	–	–	1	13	14	–	–	14	20	–	–	15	28	–	1	11	16
Texas East Waters (0-200 m) for EFH	1	20	24	24	4	29	44	46	4	47	60	62	2	47	69	74	3	36	49	52
Louisiana Waters West of Mississippi River (0-200 m)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
Louisiana Waters East of Mississippi River (0-200 m)	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Waters (0-200 m)	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	1
Alabama Waters (0-200 m)	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	1
Florida Panhandle Waters (0-200 m)	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	1
Florida Bend Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Southwest Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Southeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Northeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (1)	–	–	–	–	–	–	1	1	–	–	–	2	–	–	–	1	–	–	–	1
Shoreline - 20 m (2)	–	–	–	–	–	–	12	13	–	–	9	14	–	–	9	25	–	–	8	13
Shoreline - 20 m (3)	1	19	24	24	2	18	34	37	1	26	43	45	1	27	51	55	1	22	38	40
Shoreline - 20 m (4)	84	95	96	96	68	82	85	86	55	68	70	71	63	76	78	78	68	80	82	83
Shoreline - 20 m (5)	1	3	4	4	4	11	15	16	–	3	5	6	1	5	7	8	2	6	8	8

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (7)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (8)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (9)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (1)	–	–	–	–	–	1	12	12	–	–	14	20	–	–	15	27	–	1	10	15
20 m - 300 m (2)	–	8	10	10	3	20	30	32	3	40	55	57	2	39	62	67	2	27	39	41
20 m - 300 m (3)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
20 m - 300 m (4)	–	1	1	2	1	8	11	12	1	4	9	10	2	7	9	10	1	5	8	8
20 m - 300 m (5)	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (6)	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	1
20 m - 300 m (7)	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	1
20 m - 300 m (8)	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	1
20 m - 300 m (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	–	–	–	–	–	1	5	5	–	2	13	19	–	–	15	23	–	1	8	12
300 m - outer jurisdiction (2)	–	–	–	–	–	1	4	4	–	1	11	19	–	–	8	12	–	–	6	9
300 m - outer jurisdiction (3)	–	–	–	–	–	2	5	6	–	8	21	25	–	6	22	27	–	4	12	15
300 m - outer jurisdiction (4)	–	–	–	–	–	1	4	4	–	3	16	24	–	2	11	15	–	2	8	11
300 m - outer jurisdiction (5)	–	–	–	–	–	–	1	2	–	–	7	17	–	–	5	7	–	–	3	6
300 m - outer jurisdiction (6)	–	–	–	–	–	2	3	3	1	12	25	27	–	6	14	17	–	5	11	12
300 m - outer jurisdiction (7)	–	–	–	–	–	–	1	2	–	3	16	20	–	2	8	11	–	1	6	8
300 m - outer jurisdiction (8)	–	–	–	–	–	–	–	1	–	1	9	13	–	–	5	7	–	–	3	5
300 m - outer jurisdiction (9)	–	–	–	1	–	–	1	2	–	6	15	17	–	5	9	11	–	3	6	8
300 m - outer jurisdiction (10)	–	–	–	–	–	–	1	2	–	4	14	17	–	3	8	9	–	2	6	7
300 m - outer jurisdiction (11)	–	–	–	–	–	–	1	1	–	1	10	12	–	–	3	5	–	–	3	5
300 m - outer jurisdiction (12)	–	–	–	–	–	2	4	4	–	–	3	5	–	1	3	3	–	1	2	3
300 m - outer jurisdiction (13)	–	–	–	–	–	1	2	2	–	1	4	6	–	2	3	4	–	1	2	3
300 m - outer jurisdiction (14)	–	–	–	–	–	–	1	1	–	–	3	5	–	–	2	3	–	–	1	2
300 m - outer jurisdiction (15)	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	1
300 m - outer jurisdiction (16)	–	–	–	–	–	–	2	2	–	–	–	2	–	–	1	2	–	–	1	2

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	–	–	–	–	–	–	1	2	–	–	1	2	–	–	2	3	–	–	1	2
300 m - outer jurisdiction (18)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (19)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (20)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	1
300 m - outer jurisdiction (21)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (22)	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	1
300 m - outer jurisdiction (23)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (24)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	1
300 m - outer jurisdiction (25)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
300 m - outer jurisdiction (26)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
300 m - outer jurisdiction (27)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (28)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (29)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
North Atlantic Right Whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern SMA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
Sargassum (May/June)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sargassum (July/August)	–	–	–	1	1	6	10	10	–	–	–	–	–	–	–	–	–	2	2	3
Seagrass-Wakulla County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Jefferson County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Taylor County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Dixie County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Levy County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (1)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (2)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (3)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Topographic Features (4)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (5)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (6)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (7)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (8)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
Topographic Features (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (12)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	2	2	–	–	1	1
Stetson Bank	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	1
Topographic Features (13)	–	–	–	–	–	–	1	1	–	–	2	2	–	–	3	4	–	–	2	2
Topographic Features (14)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	1
Topographic Features (15)	–	–	–	–	–	–	1	1	–	1	2	3	–	1	4	4	–	1	2	2
East Flower Garden Bank	–	–	–	–	–	–	1	1	–	2	4	5	–	2	5	6	–	1	3	3
West Flower Garden Bank	–	–	–	–	–	1	1	1	–	2	5	6	–	1	3	4	–	1	2	3
Topographic Features (16)	–	–	–	–	–	–	–	–	–	1	3	3	–	1	2	3	–	1	1	2
Topographic Features (17)	–	–	–	–	–	–	1	1	–	1	2	3	–	1	2	2	–	1	1	1
Topographic Features (18)	–	–	–	–	–	–	–	–	–	1	1	1	–	–	1	1	–	–	1	1
Topographic Features (19)	–	–	–	–	–	–	–	–	–	1	2	2	–	1	1	1	–	1	1	1
Topographic Features (20)	–	–	–	–	–	1	1	1	–	1	3	3	–	1	2	2	–	1	1	2
Topographic Features (21)	–	–	–	–	–	–	1	1	–	2	4	5	–	1	2	3	–	1	2	2

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	1
Topographic Features (23)	–	–	–	–	–	–	–	–	–	1	3	3	–	1	2	2	–	–	1	1
Sonnier Bank	–	–	–	–	–	–	1	1	1	3	3	3	1	2	3	3	1	1	2	2
Topographic Features (24)	–	–	–	–	–	–	1	1	1	2	3	3	–	2	2	3	–	1	2	2
Topographic Features (25)	–	–	–	–	–	–	–	–	–	1	2	3	–	1	2	2	–	1	1	1
Topographic Features (26)	–	–	–	–	–	–	–	–	–	1	2	2	–	–	1	1	–	–	1	1
Topographic Features (27)	–	–	–	–	–	–	–	1	–	1	2	2	–	1	2	3	–	1	1	1
Topographic Features (28)	–	–	–	–	–	–	–	–	–	1	2	2	–	1	2	2	–	1	1	1
Topographic Features (29)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–
Topographic Features (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (31)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
Topographic Features (32)	–	–	–	–	–	–	–	1	–	–	1	1	–	–	1	1	–	–	1	1
Topographic Features (33)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (34)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
Topographic Features (35)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinnacle Trend	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–
Chandeleur Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pulley Ridge	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Madison Swanson	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Steamboat Lumps	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dry Tortugas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve North	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve South	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (year round)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Key Biscayne National Park	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Texas Clipper and South Texas Platform	–	–	–	–	–	–	1	2	–	–	1	1	–	–	–	–	–	–	–	1
Port Lavaca/Liberty Ship Reef	–	3	4	4	–	7	16	17	–	7	17	17	–	1	4	4	–	4	10	11
High Island	–	8	13	13	1	6	13	14	–	10	15	15	–	1	4	4	–	6	11	11
West Cameron	12	27	30	30	11	31	38	40	12	32	33	33	–	3	4	4	9	23	26	27
Galveston Area (GA 393)	–	–	–	–	–	1	2	2	–	–	2	2	–	–	1	1	–	–	1	1
Cognac Platform (MC 194)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Horseshoe Rigs (MP 306)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vermilion Area	>99	>99	>99	>99	>99	>99	>99	>99	66	66	66	66	1	1	1	1	67	67	67	67

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Vermilion Area, South Addition	3	6	6	6	3	8	9	10	7	11	13	13	–	–	–	–	3	6	7	7
Bay Marchand	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
South Timbalier	–	1	1	1	–	6	8	8	–	–	–	–	–	–	–	1	–	2	2	3
South Timbalier Area, South Addition	–	–	–	–	–	2	3	3	–	–	–	–	–	–	–	–	–	1	1	1
Panhandle FL	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
Tampa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Daytona Beach	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jacksonville	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stetson Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East Flower Garden Bank (April-Nov)	–	–	–	–	–	–	1	1	–	1	2	2	–	–	–	–	–	–	1	1
West Flower Garden Bank (April-Nov)	–	–	–	–	–	1	1	1	–	1	2	2	–	–	–	–	–	1	1	1
Chandeleur Islands (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve 1 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve 2 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 1 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)1 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)2 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)3 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)4 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)5 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by “–”.

Table C-7

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jamaica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX State Waters	–	–	–	–	–	–	–	2	–	–	1	2	–	–	–	2	–	–	–	2
West LA State Waters	–	–	1	1	–	1	3	5	–	4	8	8	–	3	9	12	–	2	5	6
East LA State Waters	6	15	17	17	13	29	38	41	14	37	42	43	12	30	38	40	11	28	34	35
MS State Waters	12	22	23	23	7	15	18	19	10	18	21	21	11	19	22	24	10	18	21	22
AL State Waters	29	43	46	47	11	22	26	26	13	18	19	20	17	25	27	28	17	27	30	30
FL Panhandle State Waters	5	17	23	27	3	13	21	22	1	3	5	5	1	4	6	7	3	9	14	15
West FL State Waters	–	–	2	4	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	2
Tortugas State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL State Waters	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
Northeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mexican Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	–	–	–	–	–	–	–	2	–	–	1	2	–	–	–	1	–	–	–	1
Texas East Waters (0-200 m) for EFH	–	–	–	–	–	–	1	2	–	–	2	3	–	–	1	3	–	–	1	2
Louisiana Waters West of Mississippi River (0-200 m)	–	–	1	1	–	2	4	7	1	7	13	16	–	5	13	17	–	4	8	10
Louisiana Waters East of Mississippi River (0-200 m)	7	16	18	18	15	30	40	43	19	43	49	50	16	35	44	46	14	31	38	39
Mississippi Waters (0-200 m)	30	39	40	41	36	50	57	60	52	67	71	71	46	60	65	66	41	54	58	60
Alabama Waters (0-200 m)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
Florida Panhandle Waters (0-200 m)	17	30	34	35	15	36	40	40	6	12	15	15	9	19	22	23	12	24	28	28
Florida Bend Waters (0-200 m)	–	1	7	9	–	2	6	7	–	–	2	2	–	1	2	3	–	1	4	5
Florida Southwest Waters (0-200 m)	–	–	2	2	–	–	1	1	–	–	1	1	–	–	–	2	–	–	1	2
Florida Keys Waters (0-200 m)	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
Florida Southeast Waters (0-200 m)	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
Florida Northeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (1)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (2)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
Shoreline - 20 m (3)	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	1	–	–	–	1
Shoreline - 20 m (4)	–	–	–	–	–	–	1	2	–	–	1	2	–	–	1	2	–	–	1	1
Shoreline - 20 m (5)	–	–	1	1	–	1	3	5	–	3	8	9	–	2	9	11	–	2	5	7

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	7	16	17	18	14	29	38	40	17	39	43	44	15	31	39	41	13	29	34	36
Shoreline - 20 m (7)	22	33	34	35	27	42	49	51	33	49	52	53	30	43	48	50	28	42	46	47
Shoreline - 20 m (8)	52	63	66	67	30	43	47	47	26	33	34	35	35	44	46	47	35	46	48	49
Shoreline - 20 m (9)	3	13	21	26	2	10	18	19	–	2	4	4	1	3	5	6	1	7	12	14
Shoreline - 20 m (10)	–	–	2	5	–	–	1	2	–	–	–	–	–	–	–	–	–	–	1	2
Shoreline - 20 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (12)	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
Shoreline - 20 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (1)	–	–	–	–	–	–	–	2	–	–	1	2	–	–	–	2	–	–	–	1
20 m - 300 m (2)	–	–	–	–	–	–	1	2	–	–	2	3	–	–	1	3	–	–	1	2
20 m - 300 m (3)	–	–	–	–	–	–	2	3	–	1	3	5	–	–	2	4	–	–	2	3
20 m - 300 m (4)	–	–	1	1	–	2	5	7	1	8	13	16	–	5	14	17	–	4	8	10
20 m - 300 m (5)	1	3	5	5	2	5	10	13	3	20	26	28	4	17	24	26	2	11	16	18
20 m - 300 m (6)	21	28	30	30	31	42	49	52	47	62	65	66	40	52	58	60	35	46	51	52
20 m - 300 m (7)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
20 m - 300 m (8)	16	28	32	32	15	36	39	39	6	12	15	15	9	19	22	23	11	24	27	28
20 m - 300 m (9)	–	1	7	9	–	3	7	7	–	1	3	3	–	1	3	5	–	1	5	6
20 m - 300 m (10)	–	–	2	2	–	–	1	1	–	–	1	1	–	–	–	2	–	–	1	2
20 m - 300 m (11)	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
20 m - 300 m (12)	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
20 m - 300 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	–	–	–	–	–	–	–	1	–	–	–	2	–	–	–	2	–	–	–	1
300 m - outer jurisdiction (2)	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	2	–	–	–	1
300 m - outer jurisdiction (3)	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	2	–	–	–	1
300 m - outer jurisdiction (4)	–	–	–	–	–	–	–	1	–	–	1	4	–	–	–	3	–	–	–	2
300 m - outer jurisdiction (5)	–	–	–	–	–	–	–	–	–	–	1	3	–	–	–	3	–	–	–	2
300 m - outer jurisdiction (6)	–	–	–	–	–	–	–	1	–	–	2	5	–	–	1	2	–	–	1	2
300 m - outer jurisdiction (7)	–	–	–	–	–	–	–	1	–	–	1	5	–	–	1	4	–	–	1	2
300 m - outer jurisdiction (8)	–	–	–	–	–	–	–	1	–	–	1	5	–	–	–	3	–	–	–	2
300 m - outer jurisdiction (9)	–	–	–	–	–	–	1	1	–	–	3	6	–	–	3	5	–	–	1	3
300 m - outer jurisdiction (10)	–	–	–	–	–	–	1	1	–	–	4	8	–	–	3	6	–	–	2	4
300 m - outer jurisdiction (11)	–	–	–	–	–	–	1	1	–	–	3	9	–	–	2	5	–	–	1	4
300 m - outer jurisdiction (12)	–	–	1	1	–	1	2	5	–	6	14	18	–	4	12	15	–	3	7	10
300 m - outer jurisdiction (13)	–	–	–	–	–	–	1	3	–	3	14	17	–	1	6	10	–	1	5	7
300 m - outer jurisdiction (14)	–	–	–	–	–	–	1	3	–	–	7	12	–	–	4	7	–	–	3	6
300 m - outer jurisdiction (15)	1	5	7	7	–	3	7	9	7	23	27	28	7	20	28	30	4	13	17	18
300 m - outer jurisdiction (16)	–	2	4	4	–	1	5	8	2	16	25	26	3	15	24	26	1	9	14	16

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	–	1	1	1	–	–	1	5	–	4	16	17	–	4	15	19	–	2	8	11
300 m - outer jurisdiction (18)	–	1	2	2	–	1	3	6	–	6	16	17	1	8	17	20	–	4	10	11
300 m - outer jurisdiction (19)	–	–	2	2	–	–	3	6	–	3	12	12	–	4	15	16	–	2	8	9
300 m - outer jurisdiction (20)	–	–	–	–	–	–	–	2	–	–	3	6	–	–	2	5	–	–	1	3
300 m - outer jurisdiction (21)	–	–	1	1	–	–	2	4	–	1	6	8	–	2	9	10	–	1	5	6
300 m - outer jurisdiction (22)	1	8	12	12	1	9	15	17	4	14	18	18	5	18	24	24	3	12	17	18
300 m - outer jurisdiction (23)	–	–	1	2	–	–	2	3	–	–	2	4	–	1	5	6	–	–	2	4
300 m - outer jurisdiction (24)	–	–	–	1	–	–	1	3	–	–	3	7	–	–	7	8	–	–	3	5
300 m - outer jurisdiction (25)	–	–	–	1	–	–	–	1	–	–	1	2	–	–	1	3	–	–	1	2
300 m - outer jurisdiction (26)	–	–	–	–	–	–	–	1	–	–	1	3	–	–	1	4	–	–	1	2
300 m - outer jurisdiction (27)	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
300 m - outer jurisdiction (28)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
300 m - outer jurisdiction (29)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
North Atlantic Right Whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern SMA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Sargassum (May/June)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sargassum (July/August)	–	–	1	1	–	–	3	4	–	–	–	–	–	–	–	–	–	–	1	1
Seagrass-Wakulla County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Jefferson County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Taylor County	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Dixie County	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Levy County	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (1)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (2)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (3)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (4)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (5)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (6)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (7)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (8)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stetson Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East Flower Garden Bank	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
West Flower Garden Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (16)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (17)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (18)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (19)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (20)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (21)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (23)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sonnier Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (24)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (25)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (26)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (27)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
Topographic Features (28)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (29)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (31)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (32)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (33)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (34)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (35)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Pinnacle Trend	7	13	15	15	5	13	19	20	24	36	38	38	25	38	42	42	15	25	28	29
Chandeleur Islands	6	14	15	15	12	25	31	33	13	28	30	31	11	24	30	31	11	23	27	28

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Pulley Ridge	–	–	1	2	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
Madison Swanson	–	1	3	4	–	1	2	3	–	1	2	2	–	1	2	2	–	1	2	3
Steamboat Lumps	–	–	1	1	–	–	–	1	–	–	–	1	–	–	1	1	–	–	–	1
Dry Tortugas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve North	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve South	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Florida Keys National Marine Sanctuary (year round)	–	–	–	2	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Key Biscayne National Park	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Texas Clipper and South Texas Platform	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Port Lavaca/Liberty Ship Reef	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
High Island	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
West Cameron	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Galveston Area (GA 393)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cognac Platform (MC 194)	–	–	–	–	–	–	–	1	–	1	1	1	–	–	–	–	–	–	1	1
Horseshoe Rigs (MP 306)	–	–	1	1	–	–	1	2	1	2	2	2	–	1	1	1	–	1	1	1
Vermilion Area	–	–	–	–	–	–	1	2	–	–	1	1	–	–	–	–	–	–	–	1

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Vermilion Area, South Addition	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	–	–	–	–	1
Bay Marchand	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
South Timbalier	–	–	–	–	–	–	2	3	–	1	2	2	–	–	–	1	–	–	1	2
South Timbalier Area, South Addition	–	–	–	–	–	–	1	2	–	–	2	2	–	–	–	–	–	–	1	1
Panhandle FL	6	17	23	24	5	20	24	25	1	3	4	4	–	–	1	1	3	10	13	14
Tampa	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Daytona Beach	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jacksonville	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stetson Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East Flower Garden Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Flower Garden Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chandeleur Islands (April-Nov)	6	14	15	15	12	25	31	33	10	20	21	21	–	1	3	4	7	15	18	18
Tortugas Ecological Reserve 1 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve 2 (April-Nov)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (April-Nov)	–	–	–	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1

Table C-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 2 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)1 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)2 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)3 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)4 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)5 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-8

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jamaica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX State Waters	–	–	15	19	–	–	8	32	–	–	10	22	–	–	13	45	–	–	11	30
West LA State Waters	–	15	50	54	–	2	7	12	–	1	3	6	–	2	9	13	–	5	17	21
East LA State Waters	–	1	3	3	–	–	1	2	–	–	–	1	–	–	1	1	–	–	1	2
MS State Waters	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL State Waters	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
FL Panhandle State Waters	–	–	3	5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	2
West FL State Waters	–	–	–	2	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	1
Tortugas State Waters	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Southeast FL State Waters	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	1
Northeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mexican Waters	–	–	–	–	–	–	1	5	–	–	–	5	–	–	–	2	–	–	–	3

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	–	–	1	1	–	–	7	23	–	–	10	22	–	–	4	24	–	–	6	18
Texas East Waters (0-200 m) for EFH	–	1	18	21	–	2	18	33	–	1	20	33	–	–	27	47	–	1	21	33
Louisiana Waters West of Mississippi River (0-200 m)	14	57	75	79	3	18	38	47	2	13	25	33	4	25	47	55	6	28	46	53
Louisiana Waters East of Mississippi River (0-200 m)	–	2	7	8	–	–	2	3	–	–	–	–	–	–	2	2	–	1	3	3
Mississippi Waters (0-200 m)	–	2	8	9	–	–	2	3	–	–	–	–	–	–	1	1	–	–	3	3
Alabama Waters (0-200 m)	–	2	8	10	–	–	2	3	–	–	–	–	–	–	1	1	–	–	3	4
Florida Panhandle Waters (0-200 m)	–	1	7	9	–	–	1	2	–	–	–	–	–	–	1	1	–	–	2	3
Florida Bend Waters (0-200 m)	–	–	1	5	–	–	1	3	–	–	–	–	–	–	1	1	–	–	1	2
Florida Southwest Waters (0-200 m)	–	–	–	3	–	–	2	4	–	–	–	1	–	–	1	3	–	–	1	2
Florida Keys Waters (0-200 m)	–	–	–	1	–	–	1	2	–	–	–	1	–	–	–	2	–	–	–	2
Florida Southeast Waters (0-200 m)	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	1	–	–	–	1
Florida Northeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (1)	–	–	–	–	–	–	1	4	–	–	–	3	–	–	–	1	–	–	–	2
Shoreline - 20 m (2)	–	–	1	1	–	–	3	19	–	–	5	12	–	–	3	21	–	–	3	13
Shoreline - 20 m (3)	–	–	16	20	–	1	8	18	–	–	7	16	–	–	13	30	–	–	11	21
Shoreline - 20 m (4)	–	6	28	30	–	1	6	11	–	1	3	5	–	–	9	13	–	2	12	15
Shoreline - 20 m (5)	1	20	39	41	–	2	8	12	–	2	3	4	–	3	8	11	–	7	15	17

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	–	1	3	3	–	–	1	2	–	–	–	–	–	–	–	1	–	–	1	1
Shoreline - 20 m (7)	–	–	2	3	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	1
Shoreline - 20 m (8)	–	–	2	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Shoreline - 20 m (9)	–	–	3	5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	2
Shoreline - 20 m (10)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (12)	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	2	–	–	–	1
Shoreline - 20 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
20 m - 300 m (1)	–	–	1	1	–	–	7	23	–	–	10	22	–	–	4	24	–	–	6	18
20 m - 300 m (2)	–	1	14	16	–	2	19	32	–	1	21	36	–	–	27	46	–	1	20	33
20 m - 300 m (3)	1	20	36	39	1	11	28	37	–	11	23	32	–	14	39	47	–	14	32	39
20 m - 300 m (4)	17	52	63	65	4	16	30	35	3	7	10	12	5	20	29	32	7	24	33	36
20 m - 300 m (5)	–	3	7	8	–	–	2	3	–	–	–	–	–	1	2	2	–	1	3	3
20 m - 300 m (6)	–	2	8	10	–	–	2	3	–	–	–	–	–	–	1	2	–	1	3	4
20 m - 300 m (7)	–	2	9	11	–	–	2	3	–	–	–	–	–	–	1	1	–	–	3	4
20 m - 300 m (8)	–	1	7	10	–	–	1	2	–	–	–	–	–	–	1	1	–	–	2	4
20 m - 300 m (9)	–	–	1	6	–	–	2	5	–	–	–	–	–	–	1	1	–	–	1	3
20 m - 300 m (10)	–	–	–	3	–	–	2	4	–	–	–	1	–	–	1	4	–	–	1	3
20 m - 300 m (11)	–	–	–	1	–	–	1	3	–	–	–	1	–	–	–	2	–	–	–	2

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
20 m - 300 m (12)	–	–	–	1	–	–	–	2	–	–	–	1	–	–	–	2	–	–	–	1
20 m - 300 m (13)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (1)	–	–	–	1	–	–	8	20	–	–	11	25	–	–	4	20	–	–	6	17
300 m - outer jurisdiction (2)	–	–	–	2	–	–	9	22	–	–	13	27	–	–	4	17	–	–	7	17
300 m - outer jurisdiction (3)	–	–	3	5	–	–	9	19	–	1	18	31	–	–	12	25	–	–	11	20
300 m - outer jurisdiction (4)	–	–	1	3	–	1	16	28	–	1	23	38	–	–	12	28	–	1	13	24
300 m - outer jurisdiction (5)	–	–	1	3	–	1	14	26	–	2	17	30	–	–	9	23	–	1	10	21
300 m - outer jurisdiction (6)	–	6	12	14	–	3	19	27	–	10	27	38	–	8	31	42	–	6	22	30
300 m - outer jurisdiction (7)	–	4	11	14	–	7	27	34	–	13	36	44	–	5	30	40	–	7	26	33
300 m - outer jurisdiction (8)	–	2	8	11	–	10	27	36	–	15	37	45	–	3	23	31	–	7	24	31
300 m - outer jurisdiction (9)	20	37	45	46	9	26	39	43	9	20	26	31	10	34	47	50	12	29	39	43
300 m - outer jurisdiction (10)	24	37	44	45	32	50	63	66	42	55	63	67	39	59	67	71	34	50	59	62
300 m - outer jurisdiction (11)	3	13	19	21	6	30	44	48	17	44	60	63	8	29	44	47	8	29	42	45
300 m - outer jurisdiction (12)	42	56	61	63	14	26	35	38	8	12	13	14	18	27	32	34	21	31	35	37
300 m - outer jurisdiction (13)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
300 m - outer jurisdiction (14)	18	23	26	27	29	42	47	49	48	60	63	64	36	47	50	52	33	43	47	48

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (15)	2	7	14	17	–	1	6	7	–	–	–	–	–	1	4	5	–	3	6	7
300 m - outer jurisdiction (16)	4	17	22	23	6	17	26	27	–	2	2	3	4	10	14	16	3	11	16	17
300 m - outer jurisdiction (17)	3	13	19	19	9	20	27	29	2	8	14	17	6	14	19	21	5	14	20	22
300 m - outer jurisdiction (18)	–	4	10	12	–	5	10	12	–	1	1	2	–	1	3	5	–	3	6	8
300 m - outer jurisdiction (19)	–	2	5	9	–	2	6	8	–	–	1	1	–	1	3	4	–	1	4	5
300 m - outer jurisdiction (20)	–	2	5	8	–	5	10	12	–	1	5	8	–	5	9	10	–	3	7	10
300 m - outer jurisdiction (21)	–	–	3	6	–	1	3	5	–	–	–	1	–	–	2	3	–	–	2	3
300 m - outer jurisdiction (22)	–	1	7	12	–	–	3	5	–	–	–	1	–	–	2	2	–	–	3	5
300 m - outer jurisdiction (23)	–	–	1	5	–	–	4	7	–	–	–	1	–	–	1	3	–	–	2	4
300 m - outer jurisdiction (24)	–	1	5	9	–	3	11	13	–	1	5	8	–	4	9	11	–	2	7	10
300 m - outer jurisdiction (25)	–	–	1	3	–	–	2	5	–	–	1	2	–	–	2	6	–	–	2	4
300 m - outer jurisdiction (26)	–	–	2	4	–	–	3	5	–	–	2	3	–	1	5	8	–	–	3	5
300 m - outer jurisdiction (27)	–	–	–	1	–	–	1	3	–	–	–	2	–	–	–	1	–	–	–	2
300 m - outer jurisdiction (28)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
300 m - outer jurisdiction (29)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
North Atlantic Right Whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern SMA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sargassum (March/April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	8	–	–	–	2
Sargassum (May/June)	–	3	8	10	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	3
Sargassum (July/August)	1	1	1	1	66	66	66	66	–	–	–	–	–	–	–	–	17	17	17	17
Seagrass-Wakulla County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Jefferson County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Taylor County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Dixie County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Levy County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (1)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1
Topographic Features (2)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (3)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (4)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (5)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
Topographic Features (6)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (7)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Topographic Features (8)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Topographic Features (9)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
Topographic Features (10)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (12)	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	1	–	–	–	1
Stetson Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
Topographic Features (13)	–	–	–	–	–	–	1	1	–	–	1	1	–	–	1	1	–	–	1	1
Topographic Features (14)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	1
Topographic Features (15)	–	–	1	1	–	–	1	2	–	–	2	3	–	–	2	3	–	–	1	2
East Flower Garden Bank	–	–	1	1	–	–	1	2	–	–	3	5	–	–	3	5	–	–	2	3
West Flower Garden Bank	–	–	1	1	–	–	1	2	–	–	3	4	–	–	3	5	–	–	2	3
Topographic Features (16)	–	–	–	1	–	–	–	–	–	–	2	2	–	–	2	3	–	–	1	1
Topographic Features (17)	–	–	–	1	–	–	–	1	–	–	1	2	–	–	1	2	–	–	1	1
Topographic Features (18)	–	–	–	–	–	–	–	–	–	–	1	2	–	–	1	2	–	–	1	1
Topographic Features (19)	–	–	1	1	–	–	–	1	–	–	1	2	–	–	2	3	–	–	1	2

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (20)	–	–	1	1	–	–	1	1	–	–	2	3	–	–	2	3	–	–	1	2
Topographic Features (21)	–	–	–	1	–	–	2	3	–	–	3	4	–	–	2	4	–	–	2	3
Topographic Features (22)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	1
Topographic Features (23)	–	–	1	1	–	–	1	2	–	–	2	2	–	–	2	2	–	–	1	2
Sonnier Bank	–	–	1	1	–	–	1	1	–	–	1	1	–	–	1	2	–	–	1	1
Topographic Features (24)	–	1	1	2	–	–	1	1	–	–	2	2	–	–	3	3	–	–	2	2
Topographic Features (25)	–	–	1	1	–	–	1	2	–	1	2	2	–	1	2	3	–	–	2	2
Topographic Features (26)	–	–	–	1	–	–	1	1	–	–	1	1	–	–	2	2	–	–	1	1
Topographic Features (27)	–	1	2	2	–	–	2	3	–	1	2	3	–	1	4	5	–	1	2	3
Topographic Features (28)	–	1	1	2	–	–	1	1	–	–	1	2	–	1	2	2	–	1	1	2
Topographic Features (29)	–	–	1	1	–	–	–	1	–	–	–	–	–	–	1	1	–	–	1	1
Topographic Features (30)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	1
Topographic Features (31)	–	1	1	1	–	–	1	2	–	–	1	1	–	–	1	1	–	–	1	1
Topographic Features (32)	–	2	2	3	–	1	2	3	–	1	1	1	–	–	2	2	–	1	2	2
Topographic Features (33)	–	1	2	2	–	–	2	2	–	–	–	–	–	–	1	1	–	1	1	1
Topographic Features (34)	–	1	2	2	–	–	1	1	–	–	–	–	–	1	1	2	–	1	1	1

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (35)	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinnacle Trend	–	1	7	9	–	–	2	2	–	–	–	–	–	–	1	1	–	–	2	3
Chandeleur Islands	–	–	2	2	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	1
Florida Middle Ground	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pulley Ridge	–	–	–	2	–	–	1	2	–	–	–	–	–	–	–	2	–	–	–	1
Madison Swanson	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Steamboat Lumps	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dry Tortugas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Tortugas Ecological Reserve North	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Tortugas Ecological Reserve South	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Florida Keys National Marine Sanctuary (year round)	–	–	–	1	–	–	1	3	–	–	–	–	–	–	–	2	–	–	–	2
FL State Waters	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
Key Biscayne National Park	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Texas Clipper and South Texas Platform	–	–	–	–	–	–	1	5	–	–	1	1	–	–	–	–	–	–	–	2
Port Lavaca/Liberty Ship Reef	–	–	6	7	–	–	7	14	–	–	5	6	–	–	5	10	–	–	6	9
High Island	–	–	6	7	–	–	3	4	–	–	1	1	–	–	2	4	–	–	3	4
West Cameron	–	1	12	14	–	2	4	9	–	–	2	2	–	–	5	6	–	1	6	8
Galveston Area (GA 393)	–	–	1	1	–	–	1	2	–	–	–	1	–	–	1	2	–	–	1	1

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cognac Platform (MC 194)	–	1	2	2	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	1
Horseshoe Rigs (MP 306)	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Vermilion Area	–	5	22	24	–	2	9	13	–	1	3	3	–	–	5	7	–	2	10	12
Vermilion Area, South Addition	–	6	13	15	–	3	12	16	–	4	9	9	–	–	6	8	–	3	10	12
Bay Marchand	–	1	3	3	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
South Timbalier	2	17	27	28	–	2	7	11	–	2	2	2	–	1	2	3	1	5	9	11
South Timbalier Area, South Addition	7	25	30	31	1	5	11	14	1	3	4	4	–	1	2	3	2	9	12	13
Panhandle FL	–	–	4	6	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	2
Tampa	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Daytona Beach	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jacksonville	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stetson Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East Flower Garden Bank (April-Nov)	–	–	1	1	–	–	1	2	–	–	2	2	–	–	1	2	–	–	1	2
West Flower Garden Bank (April-Nov)	–	–	1	1	–	–	1	2	–	–	2	2	–	–	1	2	–	–	1	2
Chandeleur Islands (April-Nov)	–	–	2	2	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	1
Tortugas Ecological Reserve 1 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 3 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Tortugas Ecological Reserve 2 (April-Nov)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (April-Nov)	–	–	–	1	–	–	1	3	–	–	–	–	–	–	–	1	–	–	–	1
TX Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)1 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)2 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)3 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)4 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)5 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-9

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jamaica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX State Waters	97	>99	>99	>99	88	>99	>99	>99	76	94	99	99	77	97	99	99	84	98	99	99
West LA State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East LA State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Panhandle State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mexican Waters	–	–	–	–	–	–	–	–	–	1	1	1	–	1	1	1	–	1	1	1

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200m) for EFH	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
Texas East Waters (0-200 m) for EFH	1	2	2	2	4	5	5	5	1	5	6	6	1	5	6	6	2	4	5	5
Louisiana Waters West of Mississippi River (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Louisiana Waters East of Mississippi River (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alabama Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Panhandle Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Bend Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Southwest Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Southeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Northeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (1)	–	–	–	–	–	–	–	–	–	1	1	1	–	1	1	1	–	–	1	1
Shoreline - 20 m (2)	95	99	99	99	84	96	97	97	70	92	96	96	73	96	98	98	81	96	98	98
Shoreline - 20 m (3)	1	2	2	2	2	5	5	5	–	2	4	4	–	3	3	3	1	3	3	3
Shoreline - 20 m (4)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (5)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (7)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (8)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (1)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
20 m - 300 m (2)	1	1	1	1	3	4	4	4	1	5	6	7	1	5	5	5	1	3	4	4
20 m - 300 m (3)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
20 m - 300 m (4)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (5)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (6)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (7)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (8)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
20 m - 300 m (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (1)	–	–	–	–	–	–	–	–	1	3	5	5	1	2	3	3	1	2	2	2
300 m - outer jurisdiction (2)	–	–	–	–	–	–	–	–	–	1	2	2	–	1	2	2	–	–	1	1
300 m - outer jurisdiction (3)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	–
300 m - outer jurisdiction (4)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	2	2	–	–	1	1
300 m - outer jurisdiction (5)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	1
300 m - outer jurisdiction (6)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
300 m - outer jurisdiction (7)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	–
300 m - outer jurisdiction (8)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
300 m - outer jurisdiction (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
300 m - outer jurisdiction (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (16)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (17)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (18)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (19)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (20)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (21)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (22)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (23)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (24)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (25)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (26)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (27)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (28)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (29)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
North Atlantic Right Whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern SMA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sargassum (March/April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sargassum (May/June)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sargassum (July/August)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Wakulla County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Jefferson County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Taylor County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Dixie County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Levy County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (1)	–	–	–	–	–	–	–	–	–	1	1	1	1	1	1	1	–	–	–	–
Topographic Features (2)	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	–	–	–	–
Topographic Features (3)	–	–	–	–	–	–	–	–	–	1	1	1	–	–	1	1	–	–	–	–
Topographic Features (4)	–	–	–	–	–	–	–	–	1	1	1	1	1	1	1	1	–	1	1	1
Topographic Features (5)	–	–	–	–	–	–	–	–	1	2	2	2	1	2	2	2	–	1	1	1
Topographic Features (6)	–	–	–	–	–	–	–	–	1	1	1	1	–	1	1	1	–	1	1	1

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (7)	–	–	–	–	–	–	–	–	1	1	1	1	–	1	1	1	–	–	1	1
Topographic Features (8)	–	–	–	–	–	–	–	–	–	1	1	1	–	–	–	–	–	–	–	–
Topographic Features (9)	–	–	–	–	–	–	–	–	–	1	2	2	–	–	–	–	–	–	1	1
Topographic Features (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stetson Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East Flower Garden Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Flower Garden Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (16)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (17)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (18)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (19)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (20)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (21)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (22)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (23)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sonnier Bank	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (24)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (25)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (26)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (27)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (28)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (29)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (31)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (32)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (33)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (34)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (35)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinnacle Trend	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chandeleur Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Middle Ground	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pulley Ridge	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Madison Swanson	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Steamboat Lumps	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dry Tortugas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve North	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve South	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (year round)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Key Biscayne National Park	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Texas Clipper and South Texas Platform	–	1	1	1	–	–	–	–	–	1	1	1	–	–	–	–	–	–	–	–
Port Lavaca/Liberty Ship Reef	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
High Island	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Cameron	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Galveston Area (GA 393)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cognac Platform (MC 194)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Horseshoe Rigs (MP 306)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vermilion Area	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vermilion Area, South Addition	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bay Marchand	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
South Timbalier	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
South Timbalier Area, South Addition	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Panhandle FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tampa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Daytona Beach	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jacksonville	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stetson Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
East Flower Garden Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Flower Garden Bank (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chandeleur Islands (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve 1 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 4 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Tortugas Ecological Reserve 2 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)1 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)2 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)3 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)4 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)5 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

Table C-10

Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bahamas 5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jamaica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX State Waters	–	47	87	90	–	8	44	69	–	18	53	58	–	16	63	80	–	22	62	74
West LA State Waters	–	1	7	8	–	–	8	12	–	–	–	2	–	–	–	–	–	–	4	5
East LA State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL Panhandle State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Northeast FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mexican Waters	–	–	–	–	–	–	4	7	–	–	6	10	–	–	4	8	–	–	4	6

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	1	16	22	23	–	8	29	40	2	31	55	59	1	32	55	66	1	22	40	47
Texas East Waters (0-200 m) for EFH	60	86	92	94	30	54	67	73	36	54	60	62	38	60	67	73	41	63	72	75
Louisiana Waters West of Mississippi River (0-200 m)	1	9	13	15	2	27	42	43	–	3	5	7	–	2	5	9	1	10	16	18
Louisiana Waters East of Mississippi River (0-200 m)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Mississippi Waters (0-200 m)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Alabama Waters (0-200 m)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Florida Panhandle Waters (0-200 m)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Florida Bend Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Southwest Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Southeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Northeast Waters (0-200 m)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (1)	–	–	–	–	–	–	3	6	–	–	4	7	–	–	3	6	–	–	3	5
Shoreline - 20 m (2)	–	12	20	20	–	3	20	32	–	9	37	42	–	8	45	58	–	8	31	38
Shoreline - 20 m (3)	–	49	75	77	–	10	33	45	–	12	20	23	–	10	22	28	–	20	38	43
Shoreline - 20 m (4)	–	3	8	10	–	1	15	20	–	–	1	2	–	–	–	1	–	1	6	8
Shoreline - 20 m (5)	–	–	–	1	–	–	3	5	–	–	–	1	–	–	–	–	–	–	1	2

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (7)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (8)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shoreline - 20 m (15)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (1)	1	15	21	21	–	9	29	39	2	32	56	59	1	33	55	65	1	22	40	46
20 m - 300 m (2)	64	87	93	94	37	60	71	76	39	57	62	64	41	63	70	75	45	67	74	77
20 m - 300 m (3)	1	8	11	13	3	28	41	42	–	3	5	7	–	2	6	9	1	10	16	18
20 m - 300 m (4)	–	–	–	1	–	1	8	9	–	–	1	2	–	–	1	1	–	–	3	3
20 m - 300 m (5)	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (6)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (7)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (8)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (9)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (10)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (11)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (12)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (13)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20 m - 300 m (14)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	15	27	31	32	5	18	32	38	28	64	76	78	20	47	59	65	17	39	49	53
300 m - outer jurisdiction (2)	10	18	22	22	10	24	34	38	43	66	73	75	23	40	50	53	21	37	45	47
300 m - outer jurisdiction (3)	85	92	93	93	72	81	85	85	63	67	69	70	69	77	80	82	72	79	82	83
300 m - outer jurisdiction (4)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
300 m - outer jurisdiction (5)	–	3	6	6	4	14	20	25	1	9	20	26	3	14	21	27	2	10	17	21
300 m - outer jurisdiction (6)	4	6	8	9	11	22	29	29	–	3	6	9	–	7	14	15	4	9	14	15
300 m - outer jurisdiction (7)	1	4	5	6	6	13	18	20	–	1	5	9	–	10	18	19	2	7	12	14
300 m - outer jurisdiction (8)	–	2	3	4	–	3	8	11	–	–	4	7	–	6	15	18	–	3	8	10
300 m - outer jurisdiction (9)	–	–	1	2	–	3	10	11	–	–	2	4	–	1	4	5	–	1	4	6
300 m - outer jurisdiction (10)	–	1	2	3	–	4	9	10	–	–	3	5	–	2	8	9	–	2	6	7
300 m - outer jurisdiction (11)	–	–	1	2	–	1	4	6	–	–	2	5	–	2	10	12	–	1	4	6
300 m - outer jurisdiction (12)	–	–	–	1	–	–	4	5	–	–	1	2	–	–	1	1	–	–	1	2
300 m - outer jurisdiction (13)	–	–	–	1	–	–	3	4	–	–	1	1	–	–	1	2	–	–	1	2
300 m - outer jurisdiction (14)	–	–	–	1	–	–	2	3	–	–	1	1	–	–	1	2	–	–	1	2
300 m - outer jurisdiction (15)	–	–	–	–	–	–	1	3	–	–	–	–	–	–	–	–	–	–	–	1
300 m - outer jurisdiction (16)	–	–	–	–	–	–	2	3	–	–	–	1	–	–	–	–	–	–	1	1

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	–	–	–	–	–	–	2	3	–	–	–	1	–	–	1	1	–	–	1	1
300 m - outer jurisdiction (18)	–	–	–	–	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	1
300 m - outer jurisdiction (19)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (20)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1
300 m - outer jurisdiction (21)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (22)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (23)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (24)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
300 m - outer jurisdiction (25)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (26)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (27)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (28)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (29)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
300 m - outer jurisdiction (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
North Atlantic Right Whale	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeastern SMA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	–	–	1	1	–	–	–	–	–	–	–	–	–	2	7	9	–	1	2	3
Sargassum (May/June)	67	67	67	67	–	–	–	–	–	–	–	–	–	–	–	–	17	17	17	17
Sargassum (July/August)	1	1	1	1	66	66	66	66	–	–	–	–	–	–	–	–	17	17	17	17
Seagrass-Wakulla County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Jefferson County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Taylor County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Dixie County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Seagrass-Levy County	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (1)	–	–	–	–	–	–	–	1	–	–	2	2	–	–	2	2	–	–	1	1
Topographic Features (2)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	1
Topographic Features (3)	–	–	–	–	–	–	–	–	–	–	1	2	–	–	1	2	–	–	1	1
Topographic Features (4)	–	–	–	–	–	–	–	1	–	–	1	1	–	–	1	2	–	–	1	1
Topographic Features (5)	–	–	–	–	–	–	1	1	–	1	2	2	–	–	2	3	–	–	1	2
Topographic Features (6)	–	–	1	1	–	–	–	1	–	–	1	2	–	–	1	2	–	–	1	1
Topographic Features (7)	–	–	–	–	–	–	1	1	–	–	1	1	–	–	1	1	–	–	1	1
Topographic Features (8)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	1	1

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	–	–	1	1	–	–	1	1	–	1	2	2	–	1	2	2	–	1	1	1
Topographic Features (10)	–	–	1	1	–	–	1	1	–	–	1	1	–	1	1	2	–	–	1	1
Topographic Features (11)	–	–	–	–	–	–	1	1	–	–	1	1	–	1	2	2	–	–	1	1
Topographic Features (12)	1	3	3	3	1	2	2	2	1	2	2	3	–	2	3	3	1	2	3	3
Stetson Bank	–	2	2	2	–	1	1	1	–	–	–	1	–	–	1	1	–	1	1	1
Topographic Features (13)	–	1	1	1	–	1	2	3	–	–	1	1	–	–	1	1	–	1	1	1
Topographic Features (14)	–	1	1	1	1	1	2	2	–	1	1	1	–	1	1	1	–	1	1	1
Topographic Features (15)	1	2	2	2	–	3	4	4	–	1	1	1	–	1	1	2	–	2	2	2
East Flower Garden Bank	1	2	2	2	4	7	8	8	1	1	2	3	–	1	3	4	1	3	4	4
West Flower Garden Bank	–	1	1	2	2	7	8	9	–	–	1	2	–	–	2	3	1	2	3	4
Topographic Features (16)	–	–	–	–	–	3	4	4	–	–	–	1	–	–	–	1	–	1	1	2
Topographic Features (17)	–	1	1	1	–	1	1	2	–	–	–	–	–	–	–	1	–	1	1	1
Topographic Features (18)	–	–	1	1	–	1	2	2	–	–	–	–	–	–	–	1	–	1	1	1
Topographic Features (19)	–	–	–	1	–	2	3	3	–	–	–	1	–	–	–	1	–	1	1	1
Topographic Features (20)	–	1	1	1	–	3	4	4	–	1	1	1	–	–	–	1	–	1	2	2
Topographic Features (21)	–	–	–	–	–	3	4	5	–	–	1	1	–	–	1	1	–	1	1	2

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	–	–	–	–	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–
Topographic Features (23)	–	–	–	–	–	–	2	2	–	–	1	1	–	–	1	1	–	–	1	1
Sonnier Bank	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (24)	–	–	–	–	–	1	2	2	–	–	1	1	–	–	–	–	–	–	1	1
Topographic Features (25)	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	1	1
Topographic Features (26)	–	–	–	–	–	1	2	2	–	–	1	1	–	–	–	–	–	–	1	1
Topographic Features (27)	–	–	–	–	–	–	2	2	–	–	–	1	–	–	–	–	–	–	1	1
Topographic Features (28)	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (29)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (30)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (31)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (32)	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (33)	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (34)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Topographic Features (35)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinnacle Trend	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Chandeleur Islands	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pulley Ridge	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Madison Swanson	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Steamboat Lumps	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dry Tortugas	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve North	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve South	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (year round)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL State Waters	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Key Biscayne National Park	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Texas Clipper and South Texas Platform	–	–	–	–	–	1	5	8	–	2	5	6	–	–	–	–	–	1	3	4
Port Lavaca/Liberty Ship Reef	6	27	34	35	–	7	18	23	1	7	8	8	–	1	2	3	2	10	15	17
High Island	–	7	19	20	–	2	9	15	–	1	1	1	–	–	–	–	–	3	7	9
West Cameron	–	4	7	9	–	5	17	22	–	–	–	–	–	–	–	1	–	2	6	8
Galveston Area (GA 393)	–	2	3	3	–	1	2	3	–	–	1	1	–	–	1	1	–	1	2	2
Cognac Platform (MC 194)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Horseshoe Rigs (MP 306)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vermilion Area	–	–	3	4	–	1	12	14	–	–	–	–	–	–	–	–	–	–	4	5

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Vermilion Area, South Addition	–	1	3	4	–	8	17	18	–	–	–	–	–	–	–	–	–	2	5	6
Bay Marchand	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
South Timbalier	–	–	–	–	–	–	3	4	–	–	–	–	–	–	–	–	–	–	1	1
South Timbalier Area, South Addition	–	–	–	1	–	–	5	5	–	–	–	–	–	–	–	–	–	–	1	1
Panhandle FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tampa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Southeast FL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Daytona Beach	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jacksonville	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stetson Bank (April-Nov)	–	2	2	2	–	1	1	1	–	–	–	–	–	–	–	–	–	1	1	1
East Flower Garden Bank (April-Nov)	1	2	2	2	4	7	8	8	–	–	1	1	–	–	–	–	1	2	3	3
West Flower Garden Bank (April-Nov)	–	1	1	2	2	7	8	9	–	–	–	–	–	–	–	–	1	2	3	3
Chandeleur Islands (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve 1 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortugas Ecological Reserve 2 (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Florida Keys National Marine Sanctuary (April-Nov)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TX Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table C-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point 5 Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LA Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MS Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
AL Gulf State Waters (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)1 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)2 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)3 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)4 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
FL (East Coast and Gulf)5 (Nov-April)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Values of <0.5% are indicated by "–".

APPENDIX D

RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO OCS REGION, 2006–PRESENT

D. RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO OCS REGION, 2006–PRESENT

Published in 2013	
Study Number	Title
BOEM 2013-0111	*Socioeconomic Responses to Coastal Land Loss and Hurricanes: Measuring Resilience among Outer Continental Shelf Related Coastal Communities in Louisiana*
BOEM 2013-01110	*Meteorological and Wave Measurements for Improving Meteorological Modeling*
BOEM 2013-0112	*Offshore Drilling Industry and Rig Construction Market in the Gulf of Mexico*
BOEM 2013-0113 BOEM 2013-0114	*Energy Market and Infrastructure Information for Evaluating Renewable Energy Projects for the Atlantic and Pacific OCS Regions* *Volume I: Technical Report* *Volume II: Appendices*
BOEM 2013-01157	*South Atlantic Information Resources: Data Search and Literature Synthesis*
BOEM 2013-0120	*Platform Recruited Reef Fish, Phase II: Do Platforms Provide Habitat that Increases the Survival of Reef Fishes?*
BOEM 2013-0123	*Short-Term Movement, Home Range, and Behavior of Red Snapper around Petroleum Platforms in the Northern Gulf of Mexico, as Determined by High Resolution Acoustic Telemetry*
BOEM 2013-216	*Corals on Oil and Gas Platforms near the Flower Garden Banks: Population Characteristics, Recruitment, and Genetic Affinity*
BOEM 2013-217	*Deepwater Coral Distribution and Abundance on Active Offshore Oil and Gas Platforms and Decommissioned "Rigs-to-Reefs" Platforms*
BOEM 2013-222	*Improving the Predictive Capability of 3-D Seismic Surface Amplitude Data for Identifying Chemosynthetic Communities*
Published in 2012	
Study Number	Title
BOEM 2012-004	*Ultra-Deepwater Circulation Processes in the Gulf of Mexico*
BOEM 2012-006 BOEM 2012-007	*Evaluation of Visual Impact on Cultural Resources/Historic Properties: North Atlantic, Mid-Atlantic, and Florida Straits* *Volume I: Technical Report of Findings* *Volume II: Appendices*
BOEM 2012-008	*Inventory and Analysis of Archaeological Site Occurrence on the Atlantic OCS*
BOEM 2012-015	*Seismic Survey Mitigation Measures and Marine Mammal Observer Reports*
BOEM 2012-071	*Long-Term Trends in Environmental Parameters along the Louisiana/Mississippi Outer Continental Shelf using Remote Sensing Data*

BOEM 2012-102	*Gulf of Mexico MAG-PLAN 2012: Updated and Revised Economic Impact Model*
BOEM 2012-106	*Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard-Bottom Habitats, with Emphasis on Coral Communities: Reefs, Rigs, and Wrecks-*"Lophelia *II" Interim Report*
BOEM 2012-107	*Proceedings: Twenty-Sixth Gulf of Mexico Information Transfer Meeting*
BOEM 2012-108	*Integrated Bio-Physical Modeling of Louisiana-Texas (Latex) Shelf*
BOEM 2012-109	*Literature Search and Data Synthesis for Marine Mammals and Sea Turtles in the US Atlantic from Maine to the Florida Keys*
Published in 2011	
Study Number	Title
BOEMRE 2011-001	*Analysis of the Oil Services Contract Industry in the Gulf of Mexico Region*
BOEMRE 2011-002	*Status and Applications of Acoustic Mitigation and Monitoring Systems for Marine Mammals: Workshop Proceedings, November 17-19, 2009, Boston, Massachusetts*
BOEMRE 2011-003	*Impact of Recent Hurricane Activity on Historic Shipwrecks in the Gulf of Mexico Outer Continental Shelf*
BOEMRE 2011-004	*Archival Investigations for Potential Colonial-Era Shipwrecks in Ultra-Deepwater within the Gulf of Mexico*
BOEMRE 2011-011	*User's Guide for the 2011 Gulfwide Offshore Activities Data System (GOADS-2011)*
BOEMRE 2011-012	*Literature Synthesis for the North and Central Atlantic Ocean*
BOEMRE 2011-028	*Assessment of Opportunities for Alternative Uses of Hydrocarbon Infrastructure in the Gulf of Mexico*
BOEMRE 2011-040	*Shipwreck Research in the New Orleans Notarial Archives*
BOEM 2011-043 BOEM 2011-044	*OCS-Related Infrastructure Fact Book* *Volume I: Post-Hurricane Impact Assessment* *Volume II: Communities in the Gulf of Mexico*
BOEM 2011-054	*Diversifying Energy Industry Risk in the Gulf of Mexico: Post-2004 Changes in Offshore Oil and Gas Insurance Markets*
Published in 2010	
Study Number	Title
MMS 2010-001	*Proceedings: USA-Mexico Workshop on the Deepwater Physical Oceanography of the Gulf of Mexico, June 2007*
MMS 2010-002	*Proof of Concept for Platform Recruited Reef Fish, Phase 1: Do Platforms Provide Habitat for Subadult Red Snapper?*
MMS 2010-007	*Assessment of Marginal Production in the Gulf of Mexico and Lost Production from Early Decommissioning*

MMS 2010-015	*Low-Frequency Variability of Currents in the Deepwater Eastern Gulf of Mexico*
MMS 2010-016	*Trophic Aspects of Sperm Whales (*Physeter macrocephalus*) in the Northern Gulf of Mexico Using Stable Isotopes of Carbon and Nitrogen*
BOEMRE 2010-039	*Bank Erosion of Navigation Canals in the Western and Central Gulf of Mexico*
BOEMRE 2010-041	*Study of Deepwater Currents in the Eastern Gulf of Mexico*
BOEMRE 2010-042	*Fact Book: Offshore Oil and Gas Industry Support Sectors*
BOEMRE 2010-043	*Determination of Net Flux of Reactive Volatile Organic Compounds at the Air-Water Interface in the Gulf of Mexico*
BOEMRE 2010-044	*Full-Water Column Current Observations in the Western Gulf of Mexico*
BOEMRE 2010-045	*Year 2008 Gulfwide Emission Inventory Study*
BOEMRE 2010-046	*Multicomponent and Multifrequency Seismic for Assessment of Fluid-Gas Expulsion Geology and Gas-Hydrate Deposits: Gulf of Mexico Hydrates*
BOEMRE 2010-050	*Satellite Data Assimilation into Meteorological/Air Quality Models*
BOEMRE 2010-051	*Evaluation of NASA Aura's Data Products for Use in Air Quality Studies over the Gulf of Mexico*
BOEMRE 2010-052 BOEMRE 2010-053	*Long-Term Monitoring at the East and West Flower Garden Banks: 2004-2008* *Volume 1: Technical Report* *Volume 2: Appendices*
Published in 2009	
Study Number	Title
MMS 2009-010	*Quality Control and Analysis of Acoustic Doppler Current Profiler Data Collected on Offshore Platforms of the Gulf of Mexico*
MMS 2009-013	*Foraminiferal Communities of Bathyal Hydrocarbon Seeps, Northern Gulf of Mexico: A Taxonomic, Ecologic, and Geologic Study*
MMS 2009-023	*Loop Current Frontal Eddies Based on Satellite Remote Sensing and Drifter Data*
MMS 2009-032	*Post-Hurricane Assessment of Sensitive Habitats of the Flower Garden Banks Vicinity*
MMS 2009-039	*Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study: Final Report*
MMS 2009-043	*Blue Crab (*Callinectes sapidus*) Use of the Ship/Trinity/Tiger Shoal Complex as a Nationally Important Spawning/Hatching/Foraging Ground: Discovery, Evaluation, and Sand Mining Recommendations Based on Blue Crab, Shrimp, and Spotted Seatrout Findings*
MMS 2009-046	*Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico, Interim Report 2*

MMS 2009-048	*Outer Continental Shelf (OCS)-Related Pipelines and Navigation Canals in the Western and Central Gulf of Mexico: Relative Impacts on Wetlands Habitats and Effectiveness of Mitigation*
MMS 2009-050	*Observation of the Deepwater Manifestation of the Loop Current and Loop Current Rings in the Eastern Gulf of Mexico*
MMS 2009-051	*Proceedings: Twenty-Fifth Gulf of Mexico Information Transfer Meeting, January 2009*
 MMS 2009-055 MMS 2009-056 MMS 2009-057 MMS 2009-058	*Synthesis, Analysis, and Integration of Meteorological and Air Quality Data for the Gulf of Mexico Region* *Volume I: User's Manual for the Gulf of Mexico Air Quality Database (Version 1.0)* *Volume II: Technical Reference Manual for the Gulf of Mexico Air Quality Database* *Volume III: Data Analysis* *Volume IV: Cart Analysis of Modeling Episode Days*
MMS 2009-059	*Evaluation of Oil and Gas Platforms on the Louisiana Continental Shelf for Organisms with Biotechnology Potential*
MMS 2009-060	*Modeling Waves and Currents Produced by Hurricanes Katrina, Rita, and Wilma*
Published in 2008	
Study Number	Title
MMS 2008-001	*Deepwater Currents in the Eastern Gulf of Mexico: Observations at 25.5°N and 87°W*
MMS 2008-006	*Sperm Whale Seismic Study in the Gulf of Mexico: Synthesis Report*
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MMS 2008-012	*Proceedings: Twenty-Fourth Gulf of Mexico Information Transfer Meeting, January 2007*
MMS 2008-015	*Characterization of Northern Gulf of Mexico Deepwater Hard Bottom Communities with Emphasis on* Lophelia *Coral—*Lophelia *Reef Megafaunal Community Structure, Biotopes, Genetics, Microbial Ecology, and Geology (2004-2006)* NOTE: This study was conducted by the U.S. Geological Survey (USGS) for the Agency's Headquarters' Office, and it was funded by USGS.
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MMS 2008-024	*Executive Summary: 3rd International Deep-Sea Coral Symposium in Miami*
  MMS 2008-027 MMS 2008-028	*Long-Term Monitoring at the East and West Flower Garden Banks, 2004-2005—Interim Report* *Volume I: Technical Report* *Volume II: Appendices*
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 MMS 2008-030 MMS 2008-031	*Study of Deepwater Currents in the Northwestern Gulf of Mexico* *Volume I: Executive Summary* *Volume II: Technical Report*
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Study Number	Title
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MMS 2007-030	*Incorporation of Gulf of Mexico Benthic Survey Data into the Ocean Biogeographic Information System*
MMS 2007-031	*Idle Iron in the Gulf of Mexico*
MMS 2007-033	*Cooperative Research to Study Dive Patterns of Sperm Whales in the Atlantic Ocean*
MMS 2007-034	*Competition and Performance in Oil and Gas Lease Sales and Development in the U.S. Gulf of Mexico OCS Region, 1983-1999*
MMS 2007-035	*Seafloor Characteristics and Distribution Patterns of Lophelia pertusa and Other Sessile Megafauna at Two Upper-Slope Sites in the Northeastern Gulf of Mexico*
MMS 2007-044	*Characterization of Northern Gulf of Mexico Deepwater Hard-Bottom Communities with Emphasis on* Lophelia *Coral*
MMS 2007-056	*Full-Water Column Currents Near the Sigsbee Escarpment (91-92º W. Longitude) and Relationships with the Loop Current and Associated Warm- and Cold-Core Eddies*
MMS 2007-061	*Study of Barite Solubility and the Release of Trace Components to the Marine Environment*
MMS 2007-067	*Year 2005 Gulfwide Emission Inventory Study*
MMS 2007-068	*User's Guide for the 2008 Gulfwide Offshore Activities Data System (GOADS-2008)*
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*
  MMS 2006-044 MMS 2006-045 MMS 2006-046	*Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico* *Volume I: Executive Summary* *Volume II: Technical Report* *Volume III: Appendices*
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MMS 2006-064	*Capital Investment Decisionmaking and Trends in Petroleum Resource Development in the U.S. Gulf of Mexico*
MMS 2006-067	*Sperm Whale Seismic Study in the Gulf of Mexico, Annual Report:* *Years 3 and 4*
MMS 2006-071	*Annotated Bibliography of the Potential Environmental Impacts of Chlorination and Disinfection Byproducts Relevant to Offshore Liquefied Natural Gas Port Facilities*
MMS 2006-072	*Mica Shipwreck Project Report: Deepwater Archaeological Investigation of a 19th Century Shipwreck in the Gulf of Mexico*
 MMS 2006-073 MMS 2006-074	*Exploratory Study of Deepwater Currents in the Gulf of Mexico* *Volume I: Executive Summary* *Volume II: Technical Report*

KEYWORD INDEX

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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 the 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 communities.

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) promotes energy independence, environmental protection, and economic development through responsible, science-based management of offshore conventional and renewable energy.