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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 the USEPA.

Barrel (bbl)—A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Benthic—On or in the bottom of the sea.

Biological Opinion—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 or 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).

Cofferdam containment dome—A vertically elongated box structure designed to fit loosely over the Macondo lower marine riser package to capture escaping oil at the surface (an early containment strategy for the Macondo spill deployed in May 2010).

Coastal waters—Waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands—forested and nonforested habitats, mangroves, and marsh islands exposed to tidal activity. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for birds and other animals.

Coastal zone—The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents. See also State coastal zone boundaries.

Completion—Conversion of a development well or an exploratory well into a production well.

Condensate—Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensates generally have an API gravity of 50^{o}-120^{o}.

Continental margin—The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf—General term used by geologist to refer to the continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs in the Gulf of Mexico at about 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.

Deferral—Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from the proposed sale.

Delineation well—A well that is drilled for the purpose of determining the size and/or volume of an oil or gas reservoir.

Demersal—Living at or near the bottom of the sea.

***Deepwater Horizon* (DWH) event—**All actions stemming from the April 20, 2010, explosion and subsequent sinking of the Transocean drillship *Deepwater Horizon*, up to and including the Macondo well kill declaration on September 19, 2010.

Development—Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Document (DOCD)—A document that must be prepared by the operator and submitted to BOEM for approval before any development or production activities are conducted on a lease in the western Gulf.

Development well—A well drilled to a known producing formation to extract oil or gas; a production well; distinguished from a wildcat or exploratory well and from an offset well.

Direct employment—Consists of those workers involved the primary industries of oil and gas exploration, development, and production operations (Standard Industrial Classification Code 13—Oil and Gas Extraction).

Discharge—Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

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 (239 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 in the western Gulf.

Exploration well—A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present; exploratory well.

False crawls—Refers to when a female sea turtle crawls up on the beach to nest (perhaps) but does not and returns to the sea without laying eggs.

Field—An accumulation, pool, or group of pools of hydrocarbons in the subsurface. A hydrocarbon field consists of a reservoir in a shape that will trap hydrocarbons and that is covered by an impermeable, sealing rock.

Floating production, storage, and offloading (FPSO) system—A tank vessel used as a production and storage base; produced oil is stored in the hull and periodically offloaded to a shuttle tanker for transport to shore.

Gathering lines—A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical—Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geophysical survey—A method of exploration in which geophysical properties and relationships are measured remotely by one or more geophysical methods.

Habitat—A specific type of environment that is occupied by an organism, a population, or a community.

Hermatypic coral—Reef-building corals that produce hard, calcium carbonate skeletons and that possess symbiotic, unicellular algae within their tissues.

Harassment—An intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, feeding or sheltering.

Hydrocarbons—Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hypoxia—Depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

Incidental take—Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (see Taking).

Indirect employment—Secondary or supporting oil- and gas-related industries, such as the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants.

Induced employment—Tertiary industries that are created or supported by the expenditures of employees in the primary or secondary industries (direct and indirect employment), including consumer goods and services such as food, clothing, housing, and entertainment.

Infrastructure—The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Jack-up rig—A barge-like, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Junk shot—A wild well-control procedure accompanying a top kill that introduces foreign objects into the drilling fluid (such as shredded rope, rubber, or golf balls) and that is designed to clog the openings or partial openings in a nonfunctioning blowout preventer (an early well control strategy for the Macondo spill in May 2010).

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.

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 until 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 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 the USEPA.

Nonhazardous oil-field wastes (NOW)—Wastes generated by exploration, development, or production of crude oil or natural gas that are exempt from hazardous waste regulation under the Resource Conservation and Recovery Act (*Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes*, dated June 29, 1988, 53 FR 25446; July 6, 1988). These wastes may contain hazardous substances.

Offloading—Unloading liquid cargo, crude oil, or refined petroleum products.

Operational discharge—Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator—An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Organic matter—Material derived from living plants or animals.

Outer Continental Shelf (OCS)—All submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands.

Pelagic—Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Penaeids—Chiefly warm water and tropical prawns belonging to the family Penaeidae.

Plankton—Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Platform—A steel or concrete structure from which offshore development wells are drilled.

Play—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 (for example, cracking).

Relief—The difference in elevation between the high and low points of a surface.

Reserves—Proved oil or gas resources.

Rig—A structure used for drilling an oil or gas well.

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* 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.

Shunting—A method used in offshore oil and gas drilling and production activities where expended cuttings and fluids are discharged through a downpipe, which terminates no more than 10 m from the ocean floor, rather than discharged at the ocean surface.

Shoreline Cleanup and Assessment Team—The on-the-scene responders for post-spill shoreline protection who established priorities, standardized procedures and establish 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 CG 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.

Top hat—A short cylindrical sleeve with a tapered apex designed to fit atop of the lower marine riser package and to capture oil and gas from the flowing Macondo well (a functional subsurface recovery strategy for the Macondo spill in June and July, before the well was capped on July 15, 2010).

Top kill—A wild well-control procedure involving the pump-down under pressure of heavy drilling fluid to equalize pressure and to stop the flow of gas and oil exiting a blowout (an early well control strategy for the Macondo spill deployed in May 2010).

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.

Unified Area Command—A system of satellite work, coordination, and remediation stations administered by the Unified Incident

Commander Incident Commander during a spill of national significance.

Unified Incident Command—Command and coordination center for the National Incident Commander

Volatile organic compound (VOC)—Any organic compound that is emitted to the atmosphere as a vapor.

Water test areas—Areas within the Eastern Gulf where Department of Defense research, development, and testing of military planes, ships, and weaponry take place.

Weathering (of oil)—The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

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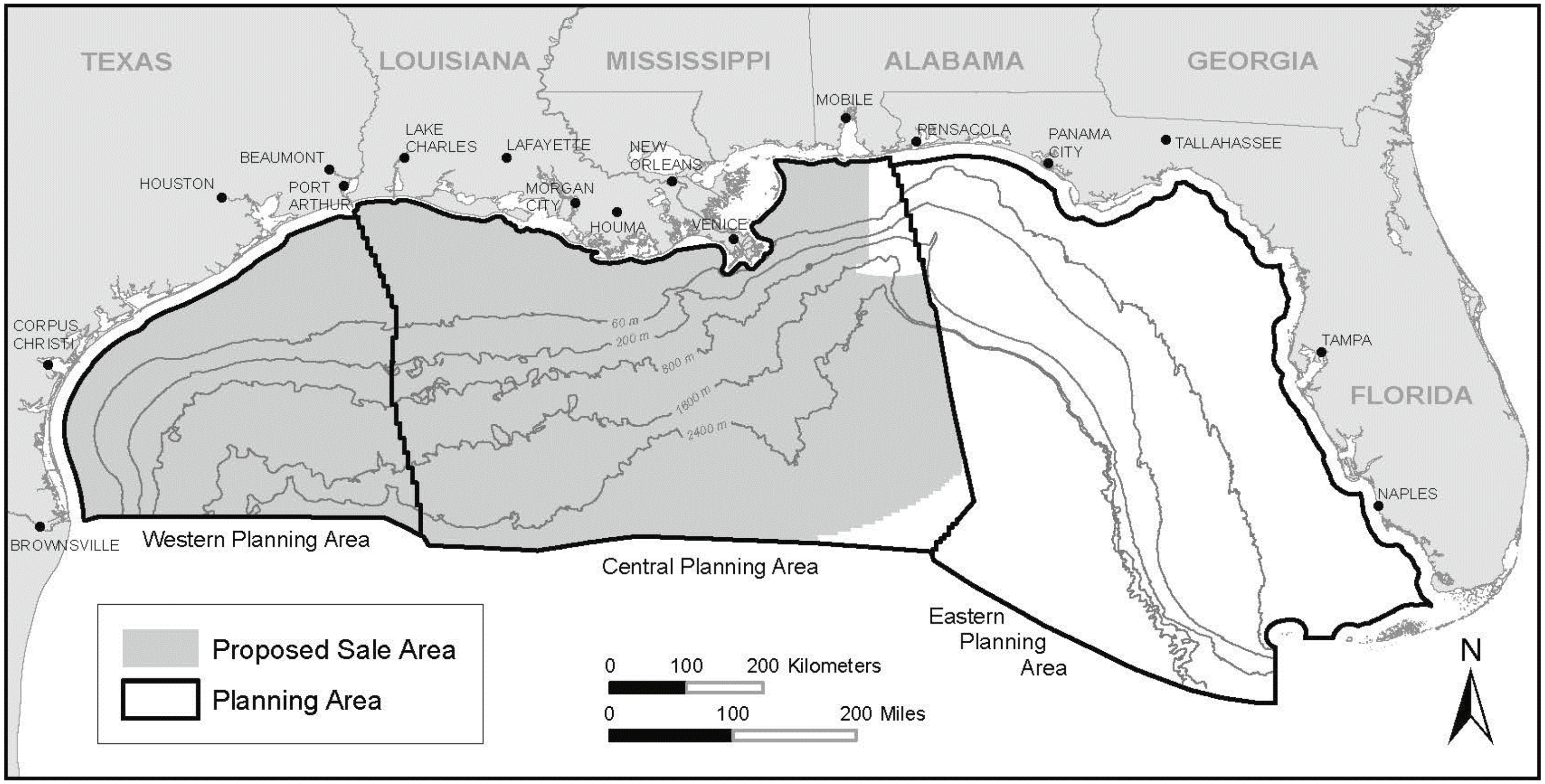
FIGURES



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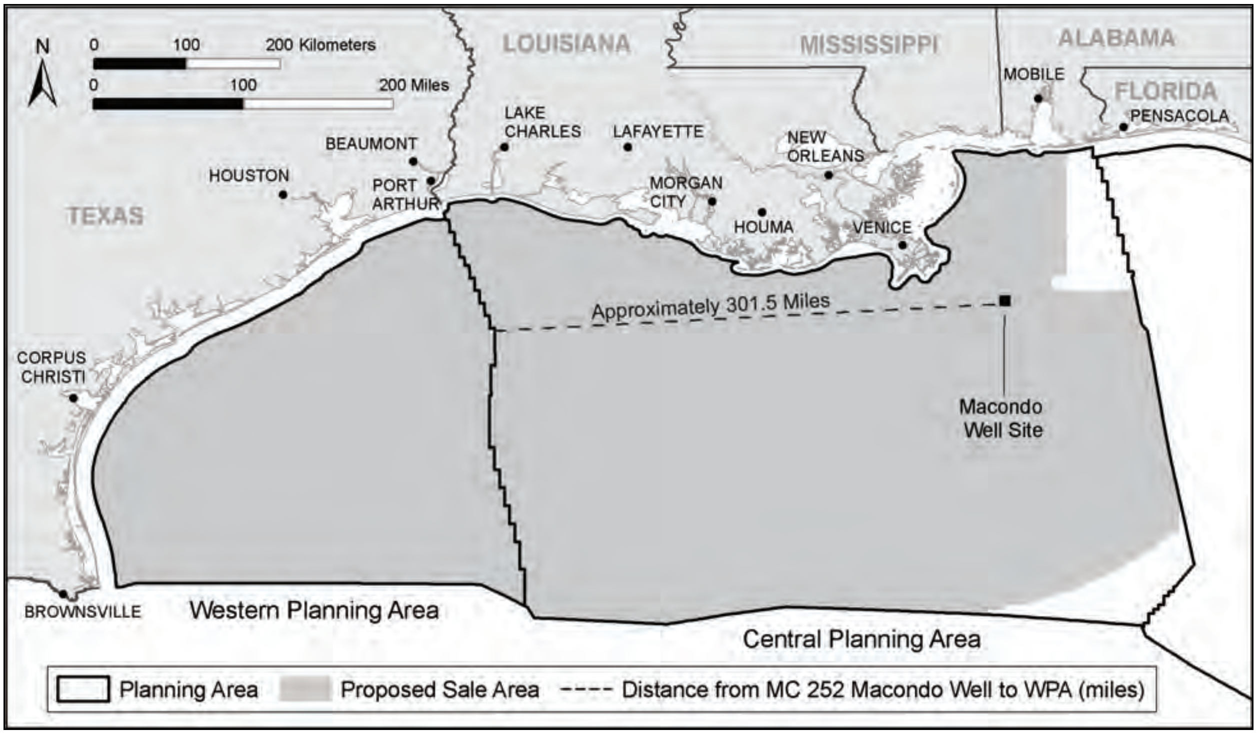

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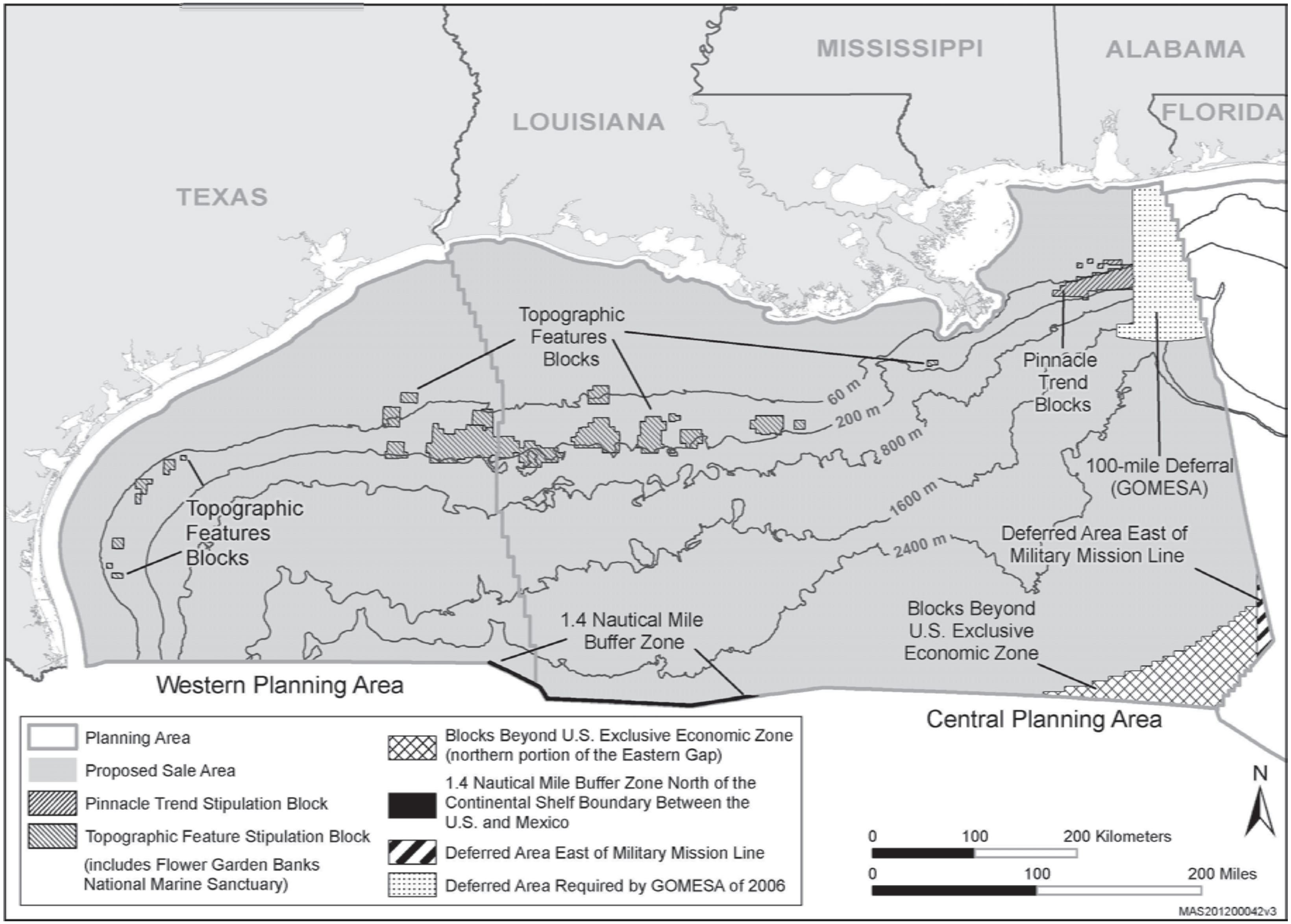

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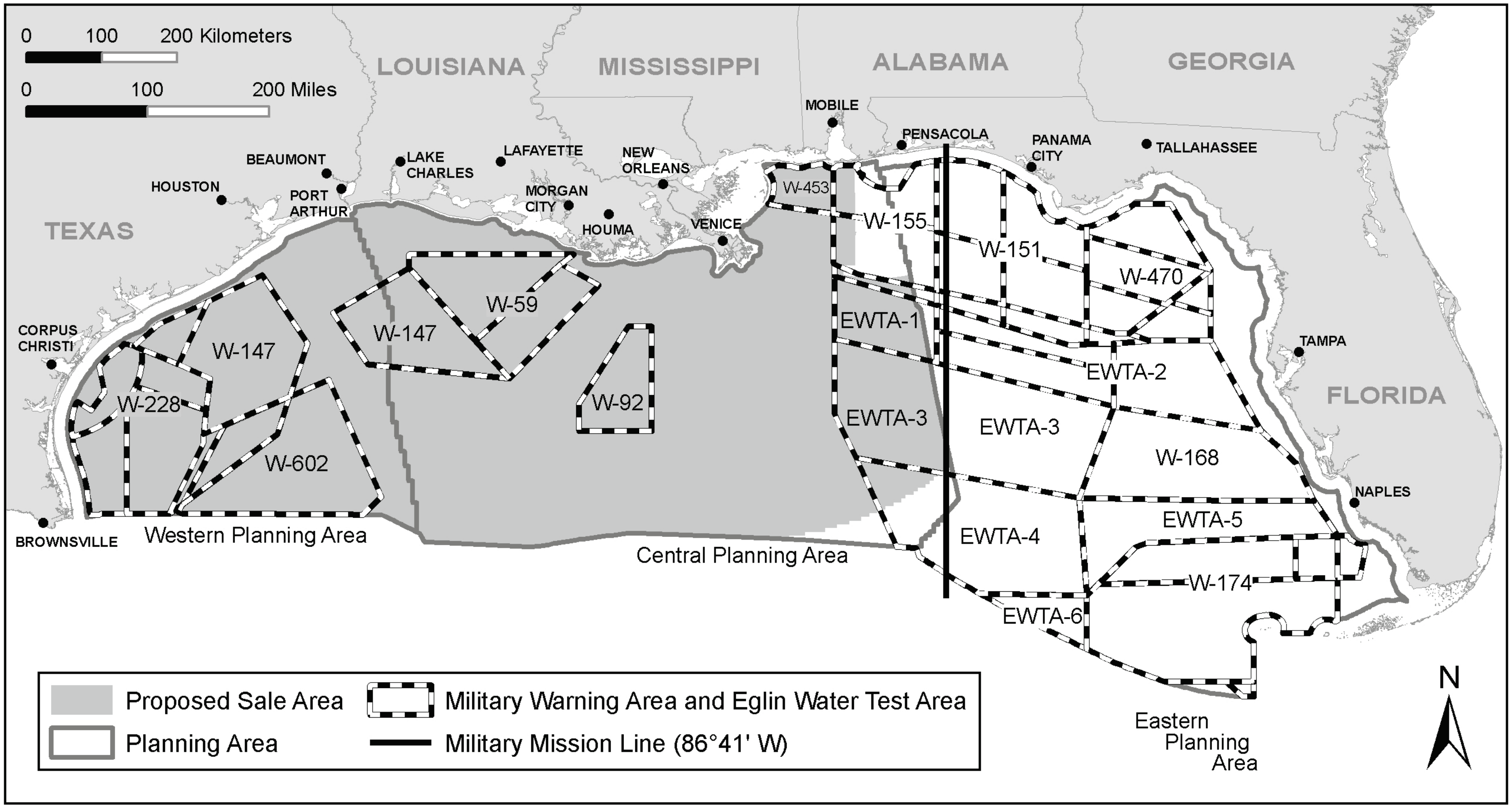

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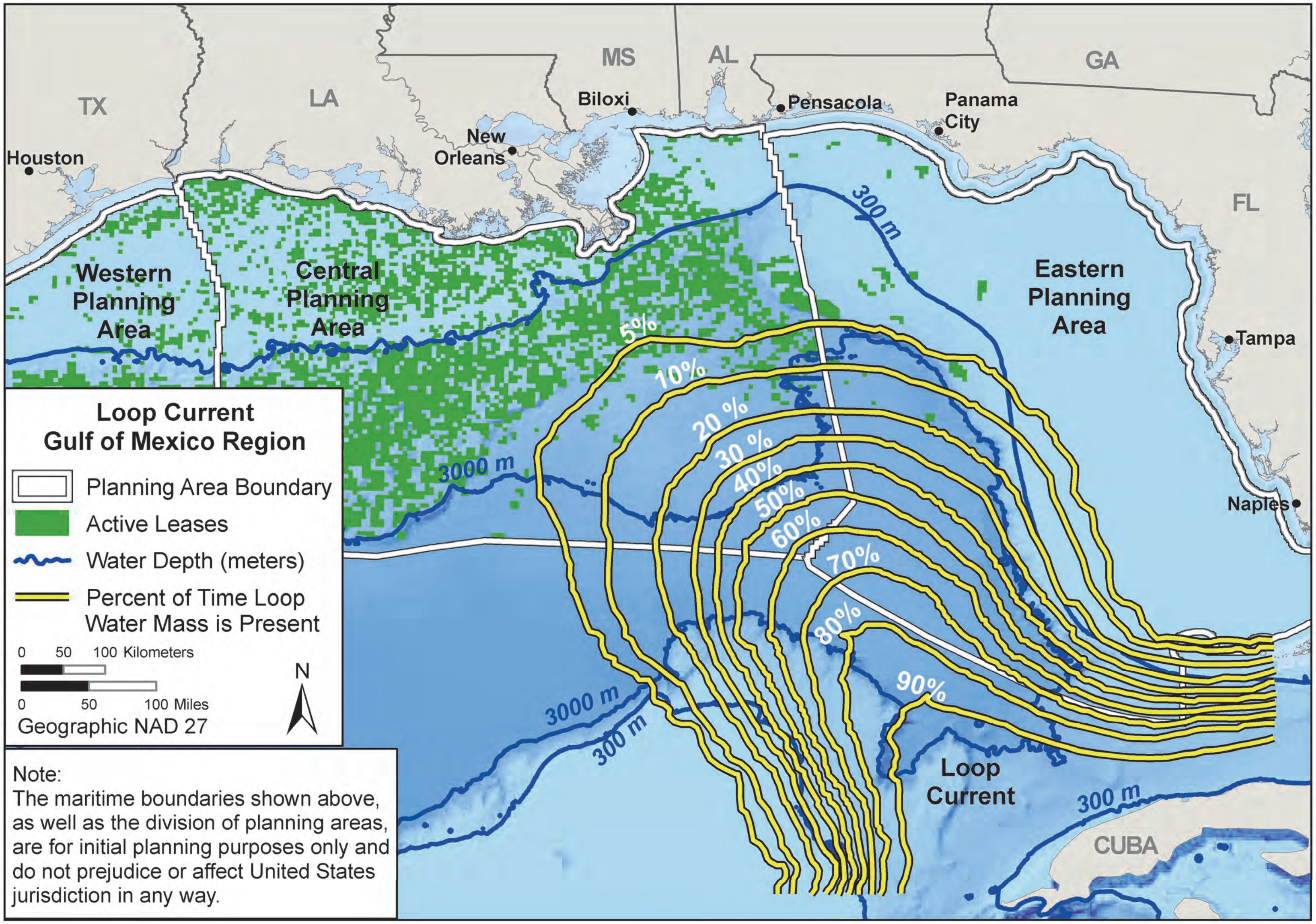

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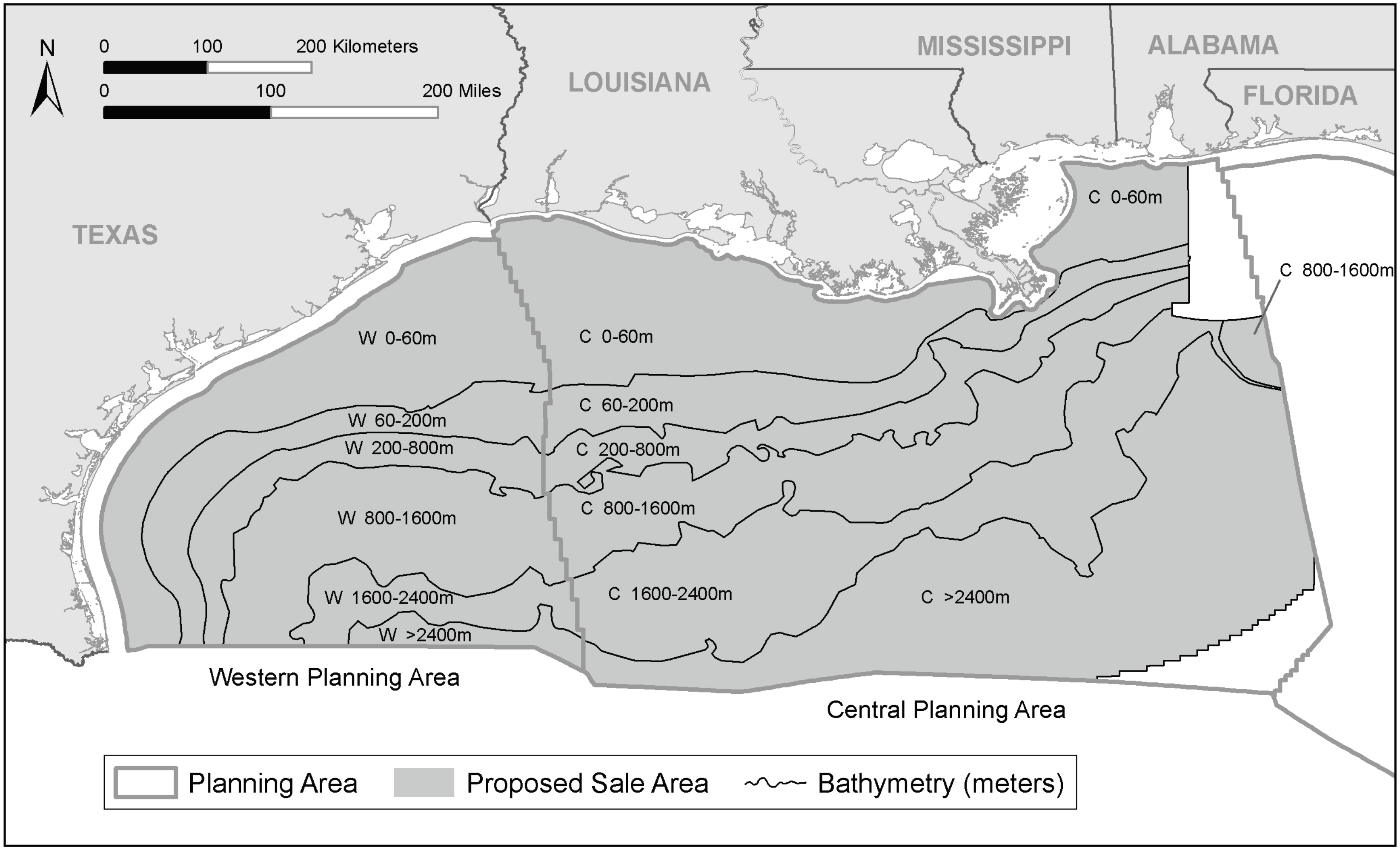

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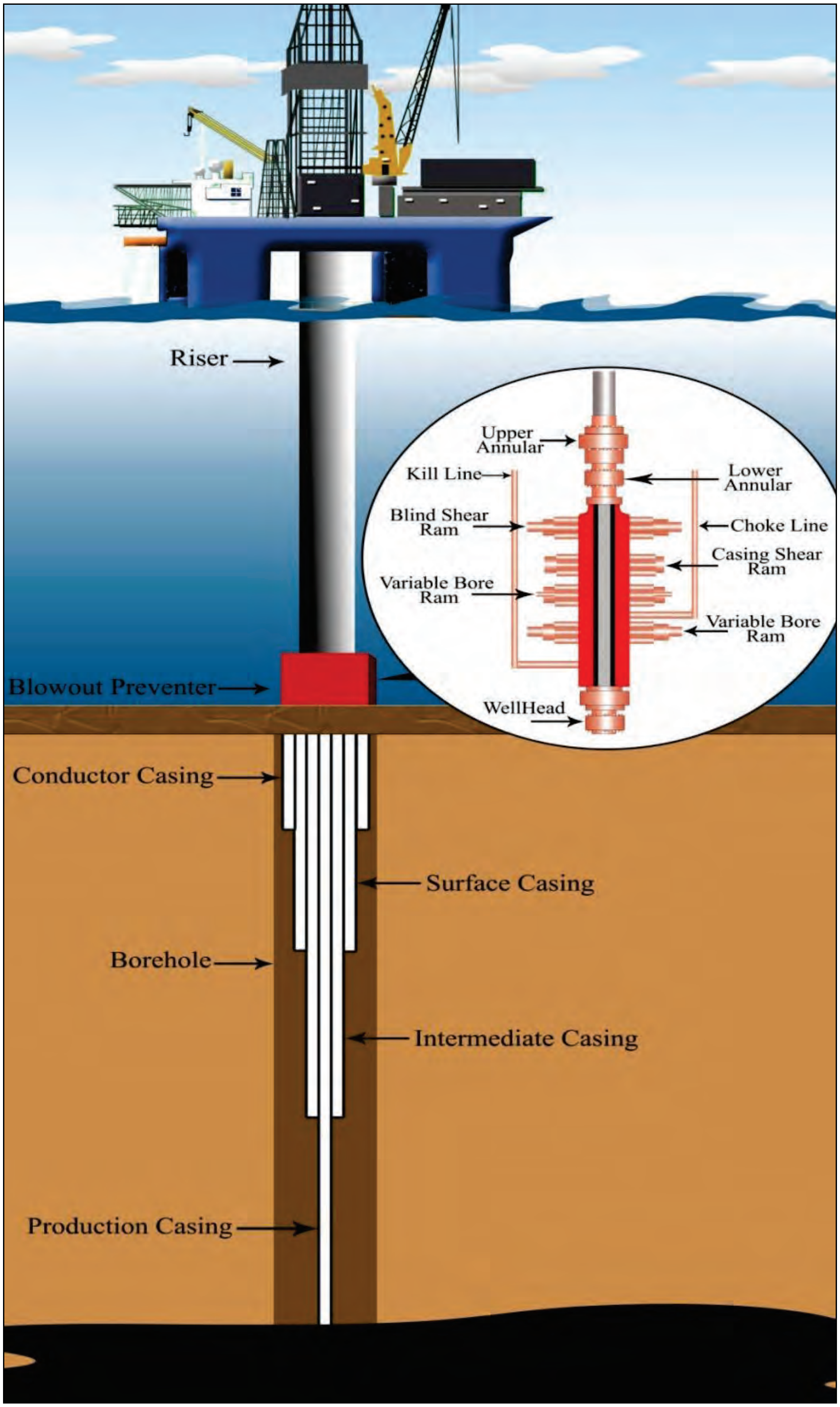

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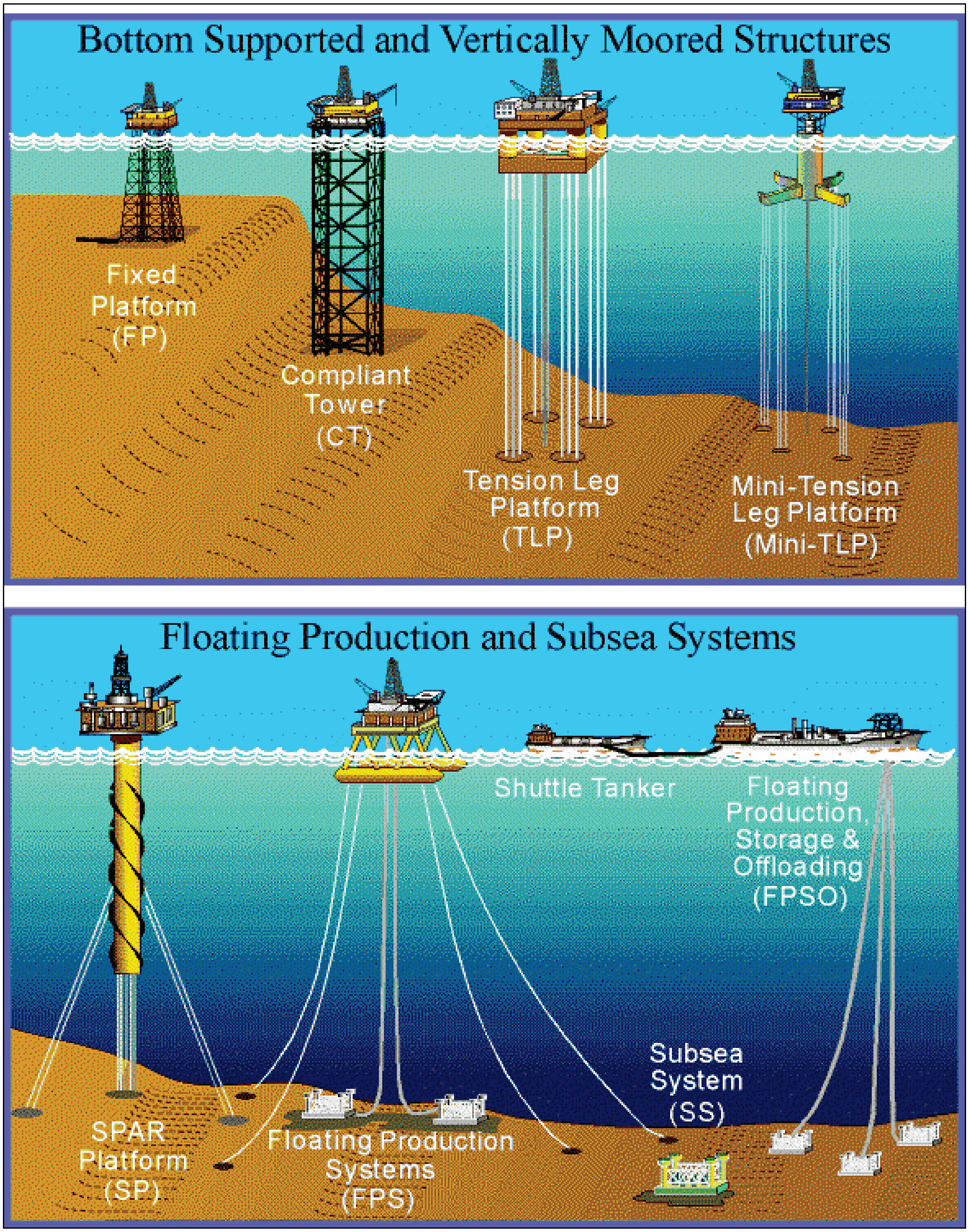

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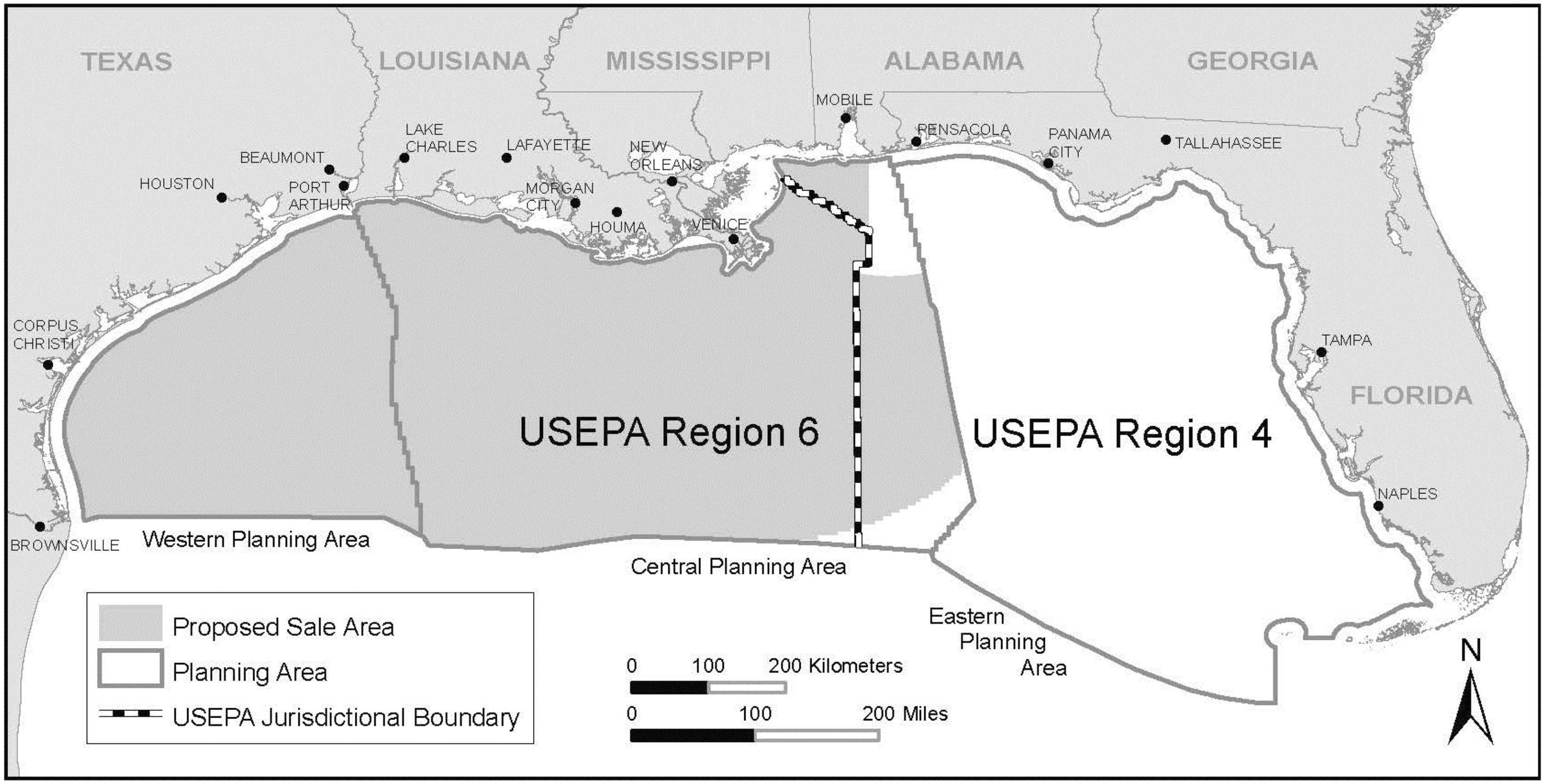

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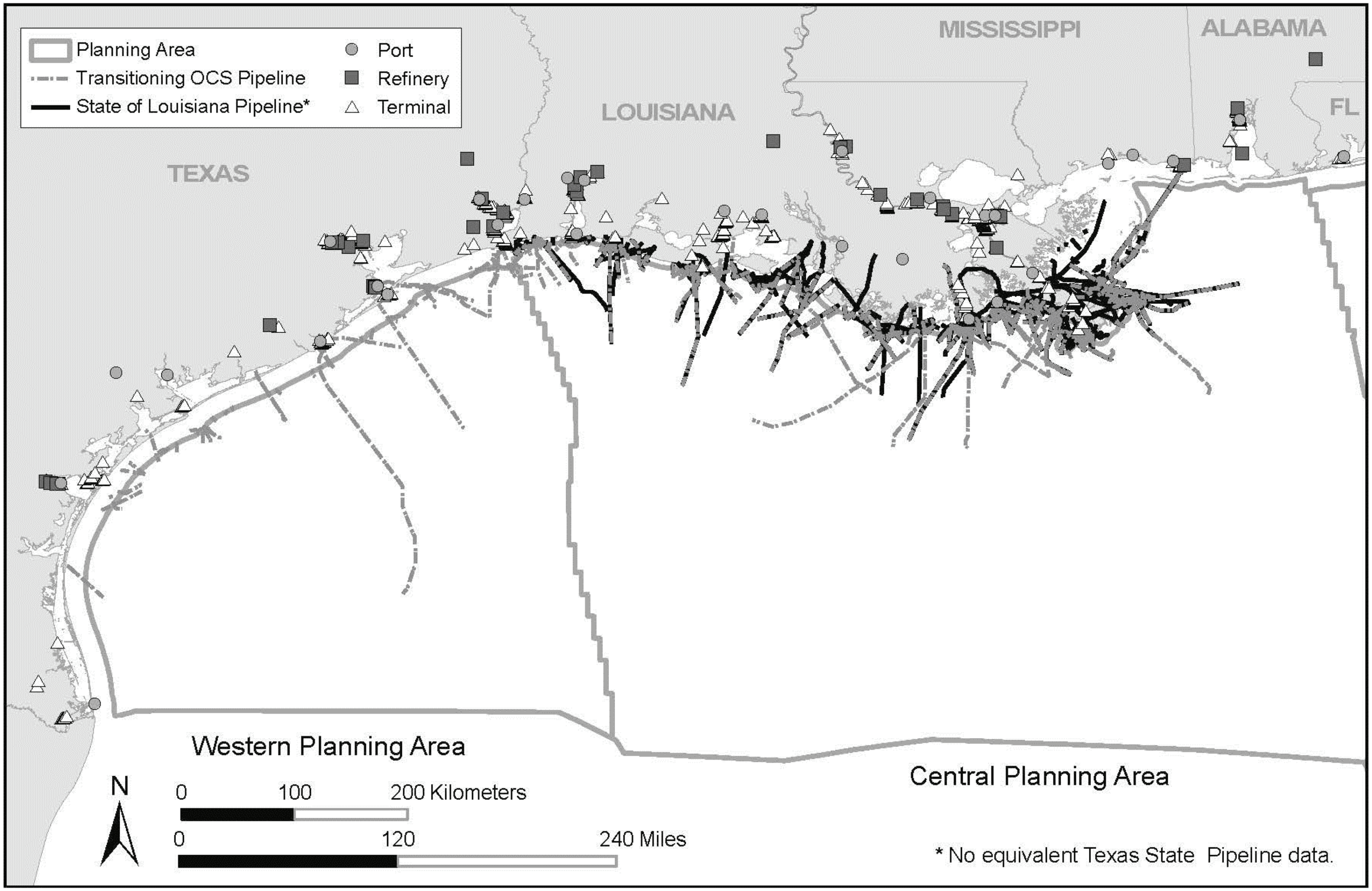

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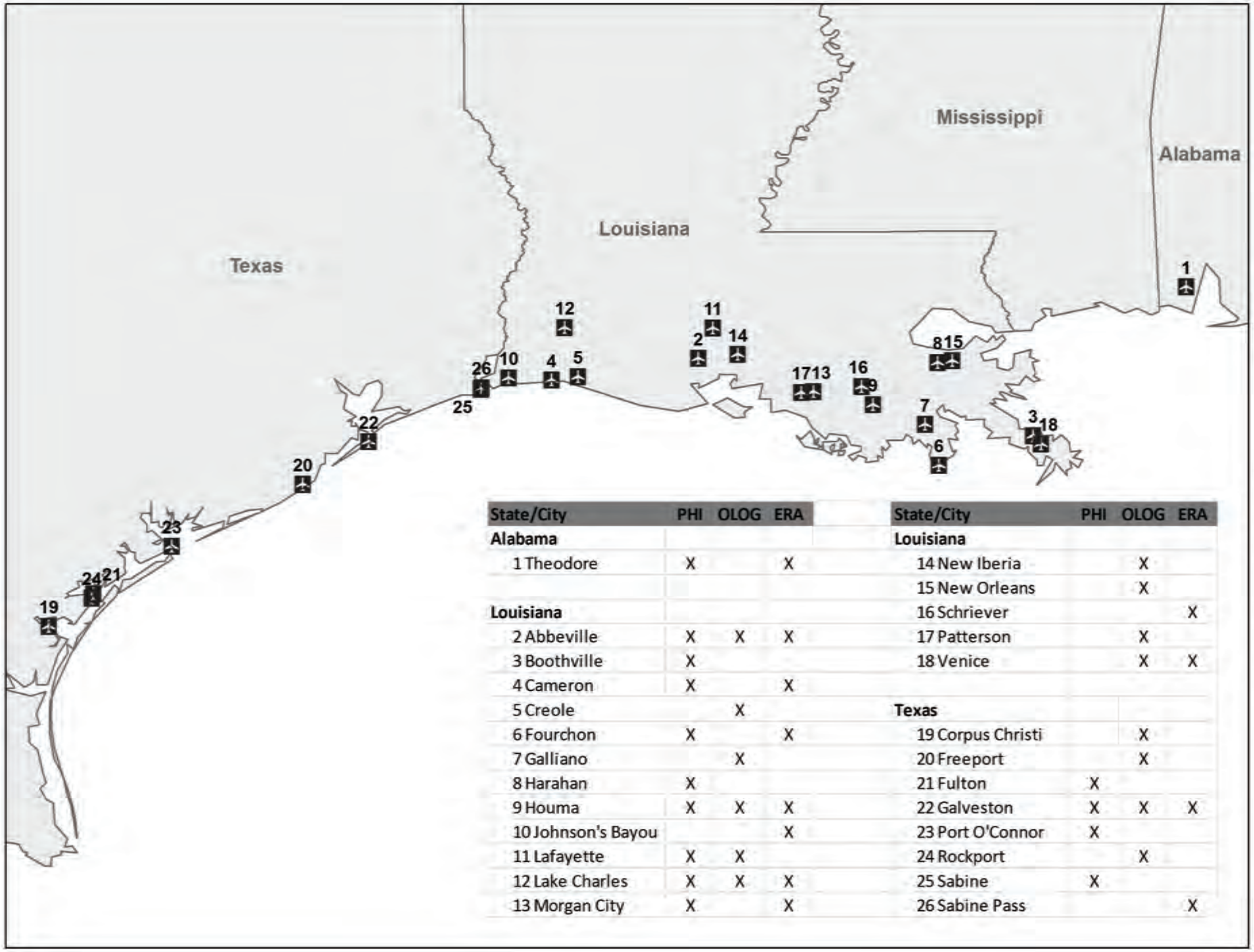

State/City	PHI	OLOG	ERA
Alabama			
1 Theodore	X		X
Louisiana			
2 Abbeville	X	X	X
3 Boothville	X		
4 Cameron	X		X
5 Creole		X	
6 Fourchon	X		X
7 Galliano		X	
8 Harahan	X		
9 Houma	X	X	X
10 Johnson's Bayou			X
11 Lafayette	X	X	
12 Lake Charles	X	X	X
13 Morgan City	X		X
14 New Iberia		X	
15 New Orleans		X	
16 Schriever			X
17 Patterson		X	
18 Venice		X	X
Texas			
19 Corpus Christi		X	
20 Freeport		X	
21 Fulton	X		
22 Galveston	X	X	X
23 Port O'Connor	X		
24 Rockport		X	
25 Sabine	X		
26 Sabine Pass			X

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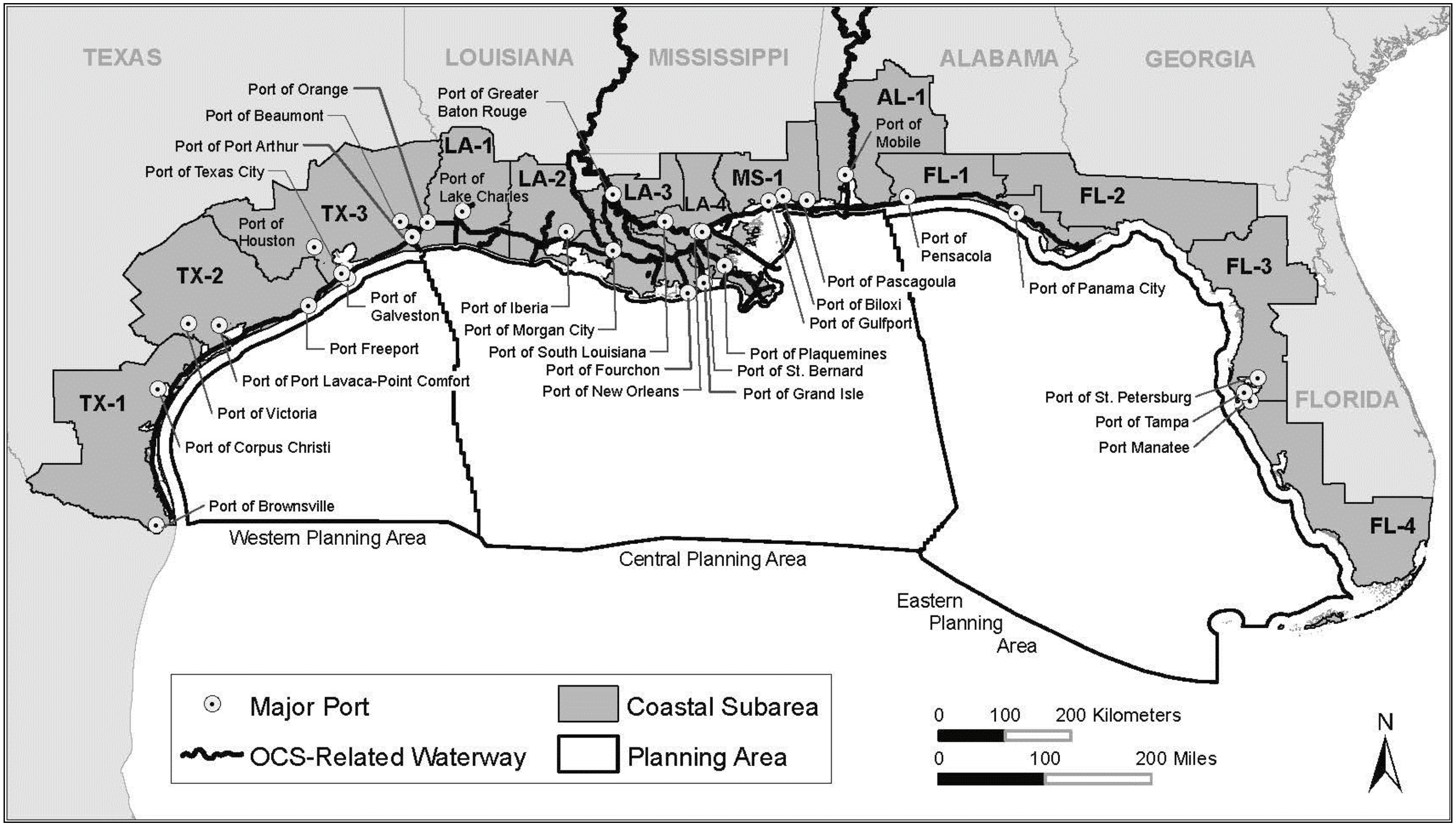

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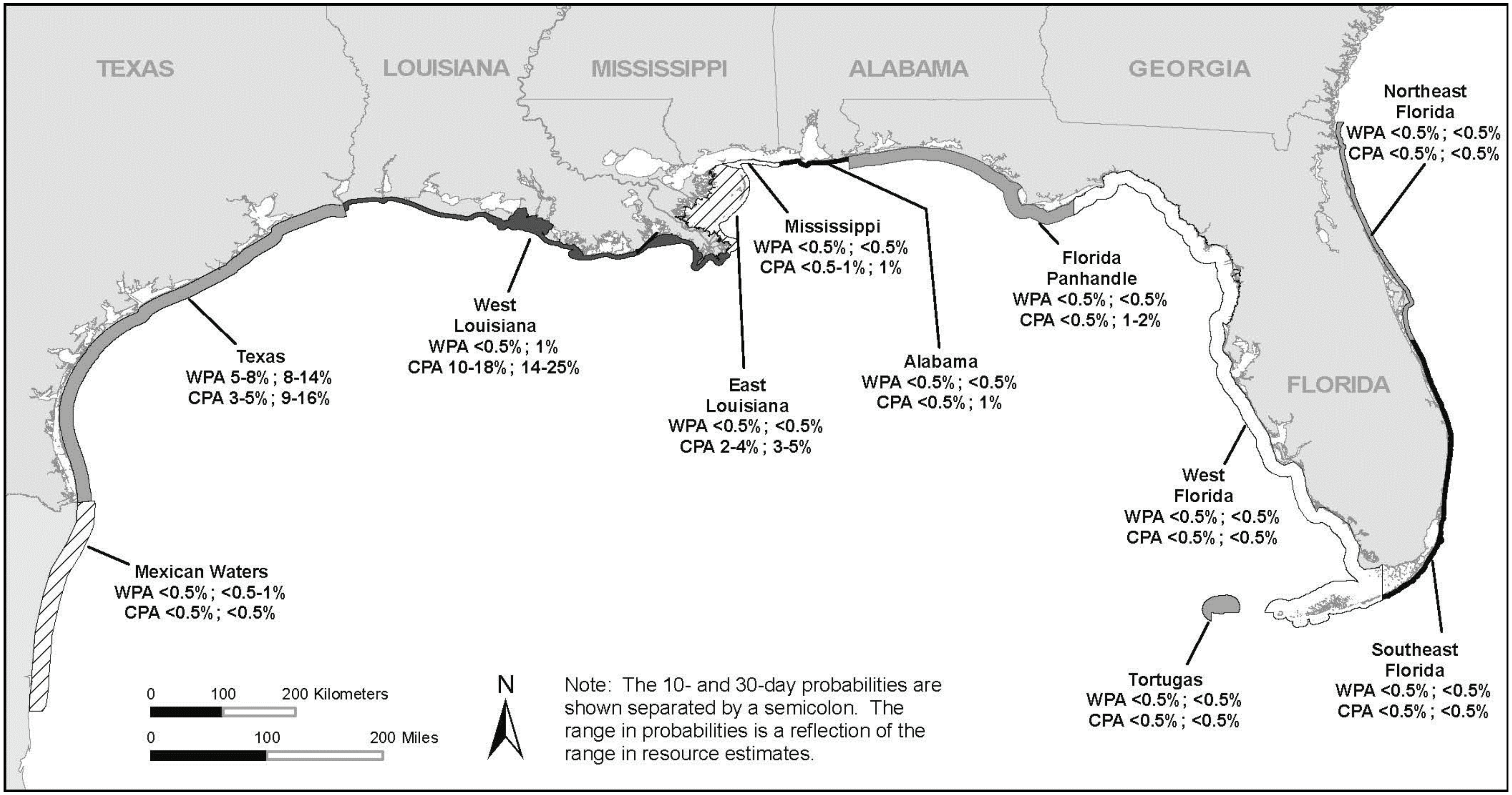

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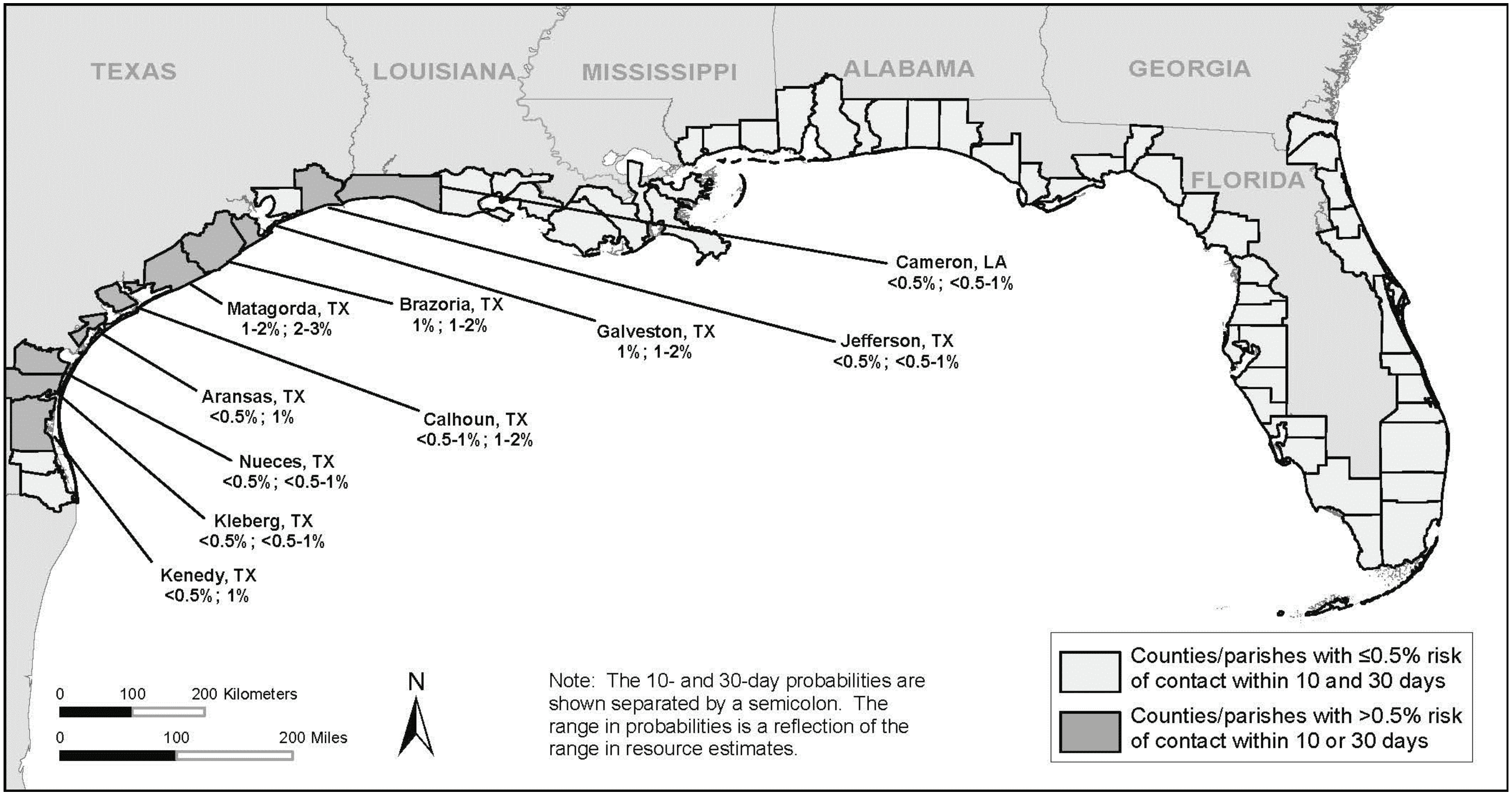

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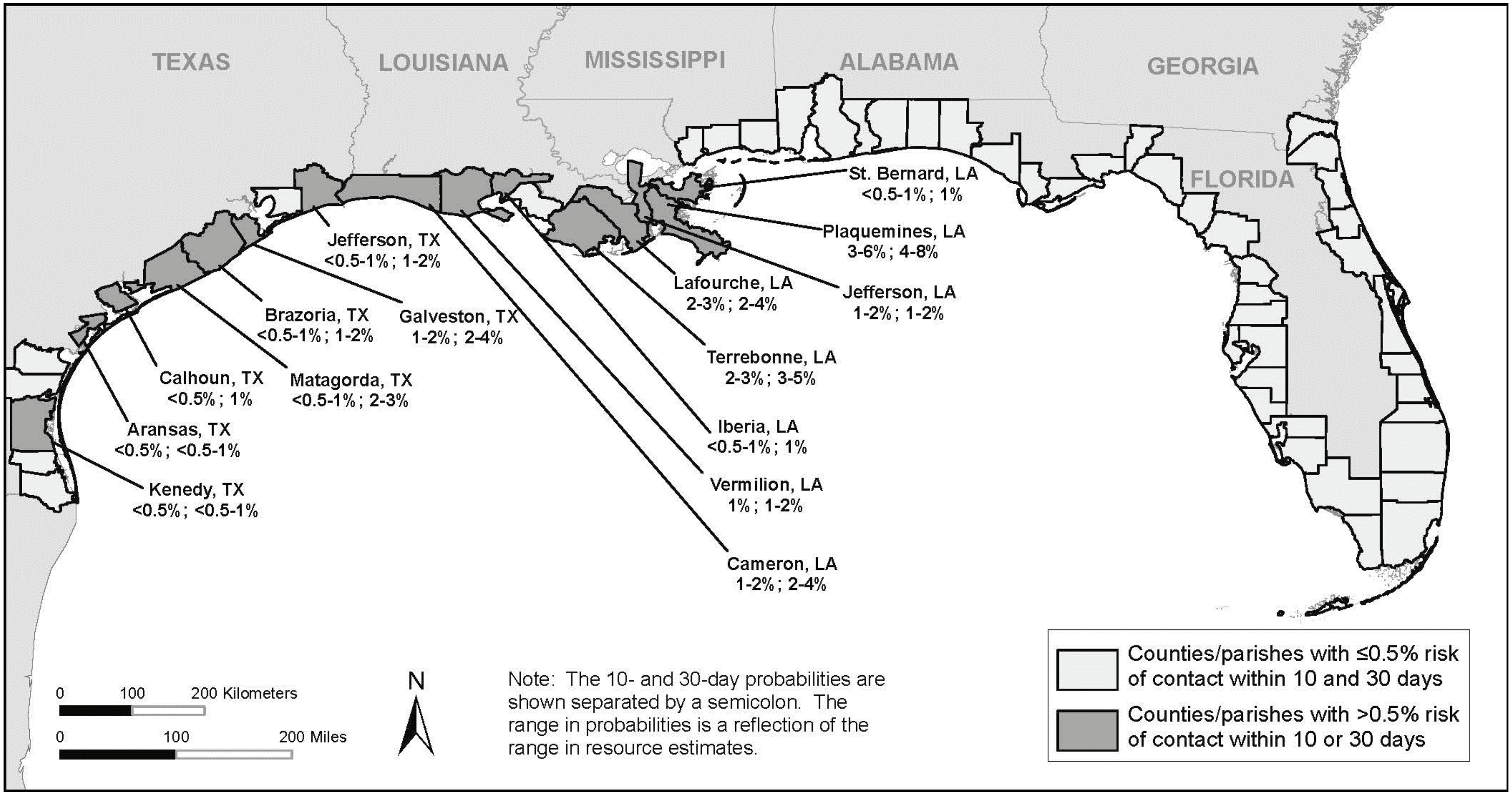

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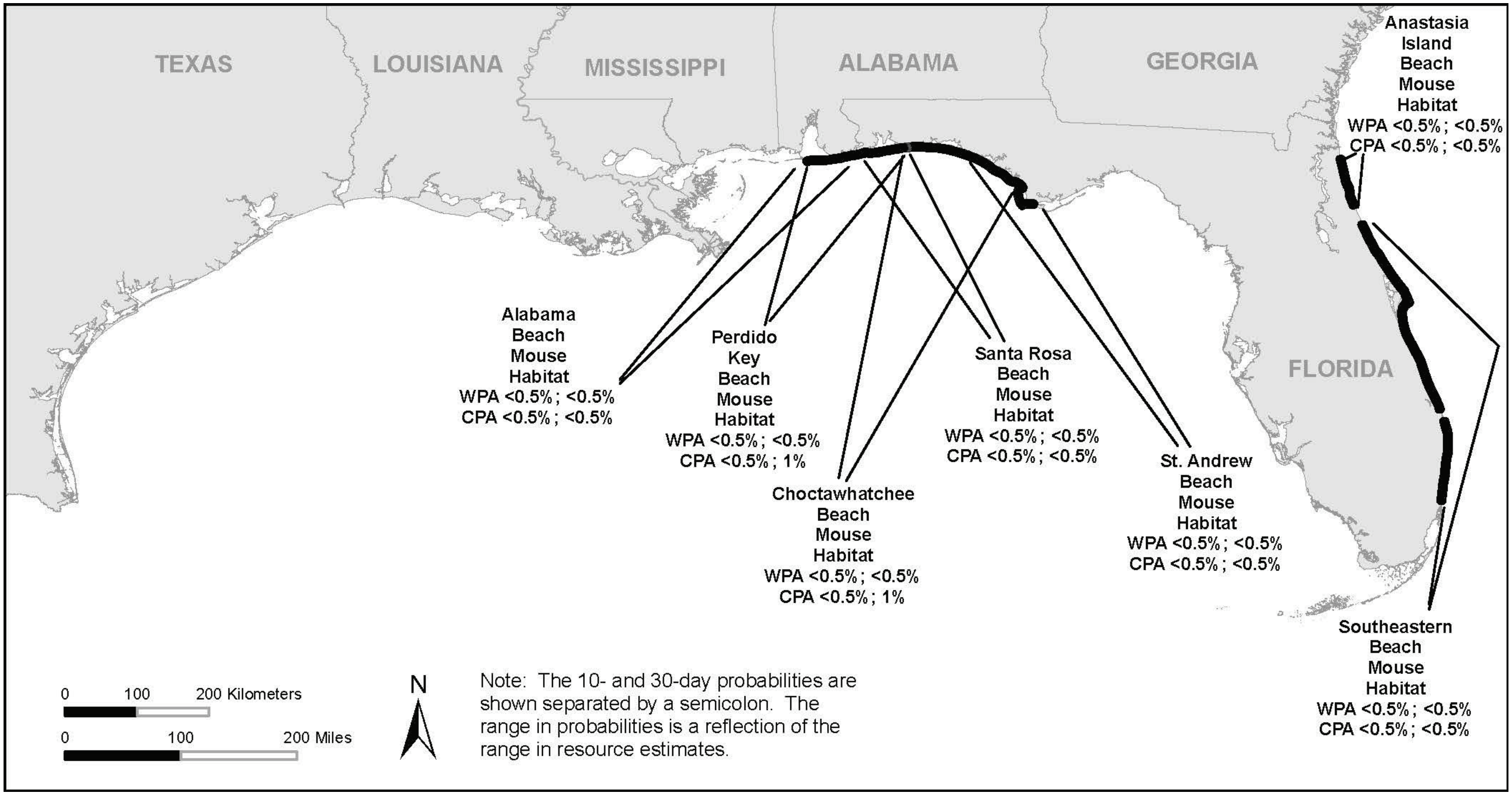

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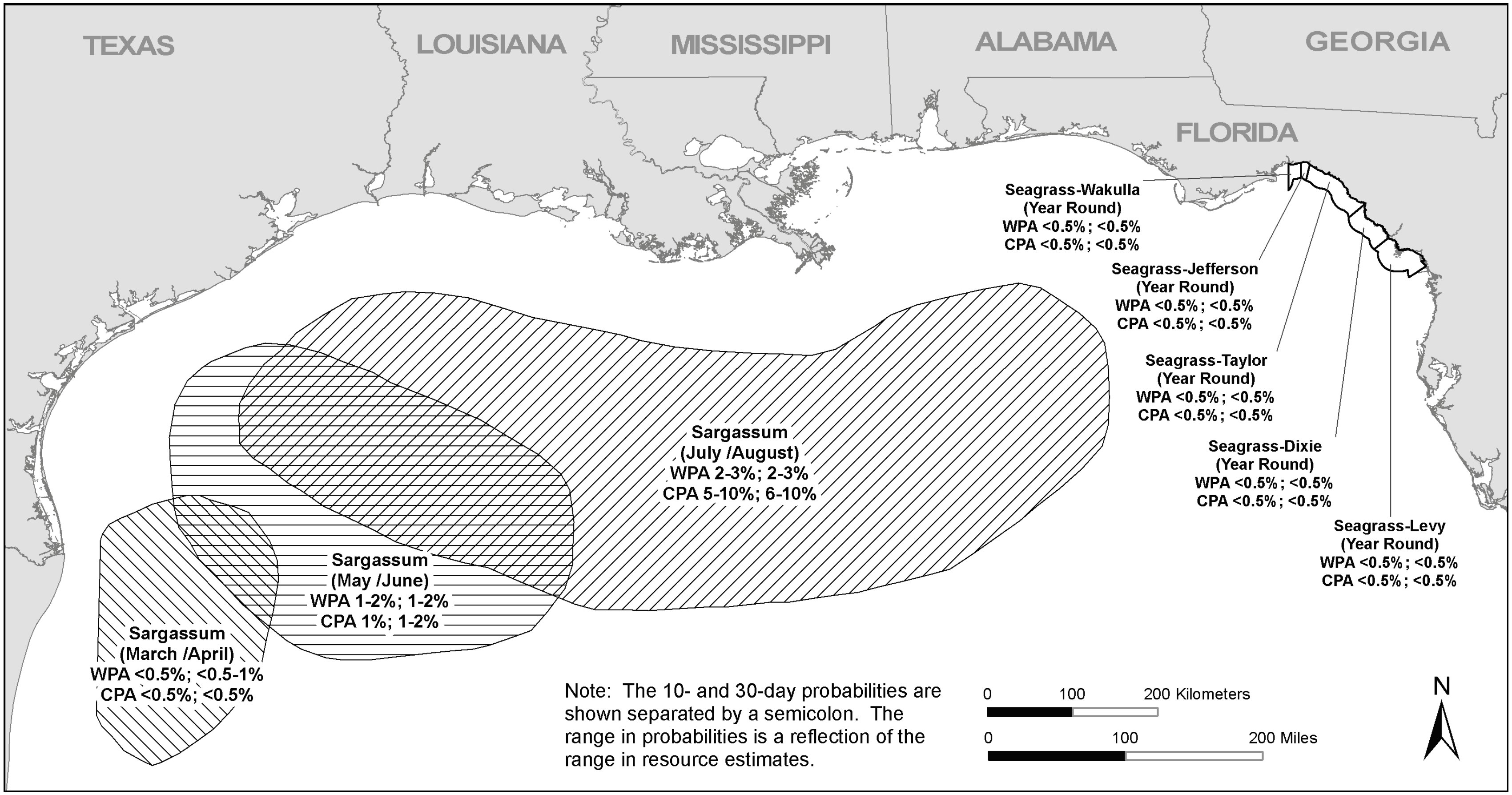

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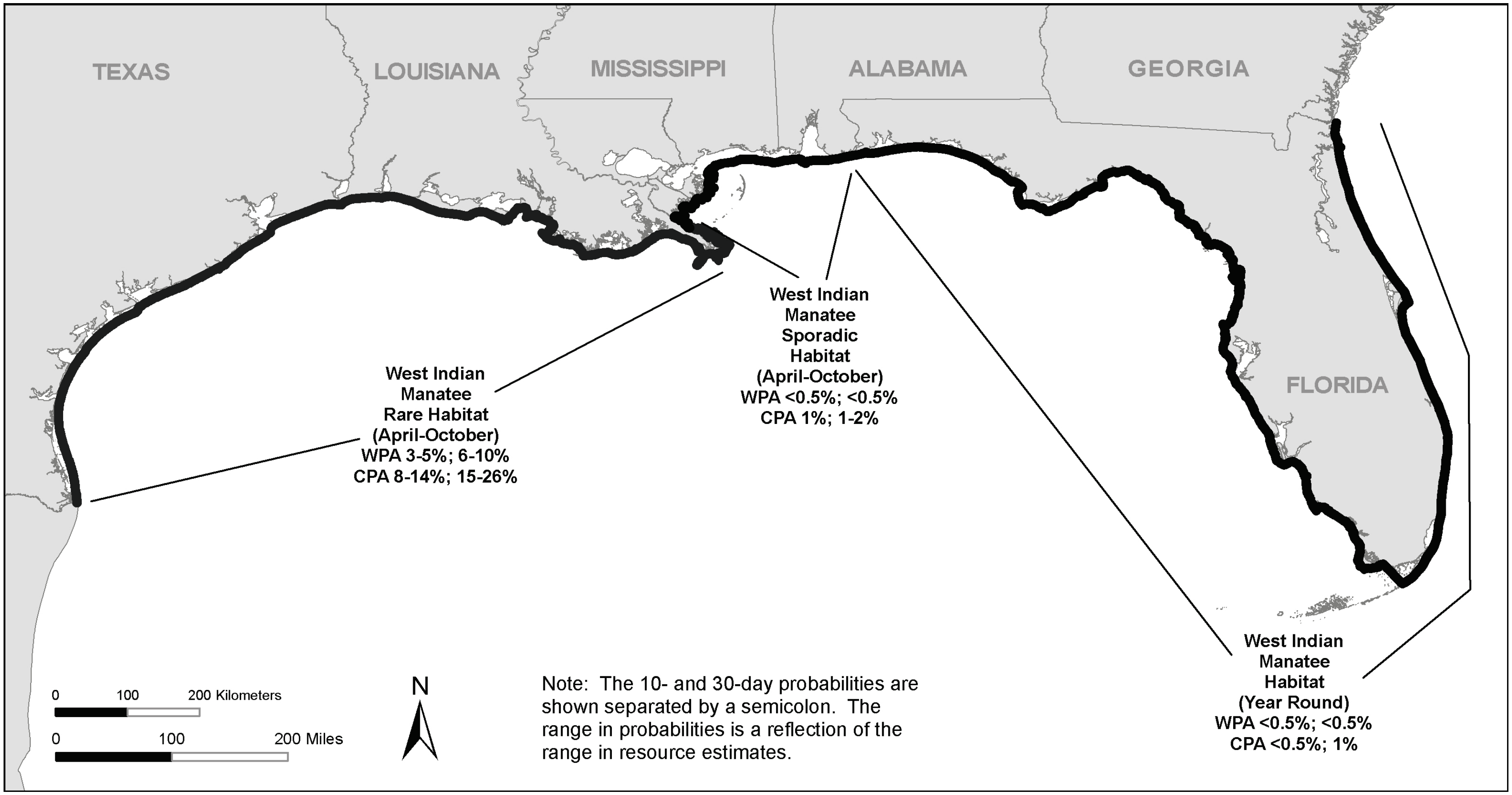

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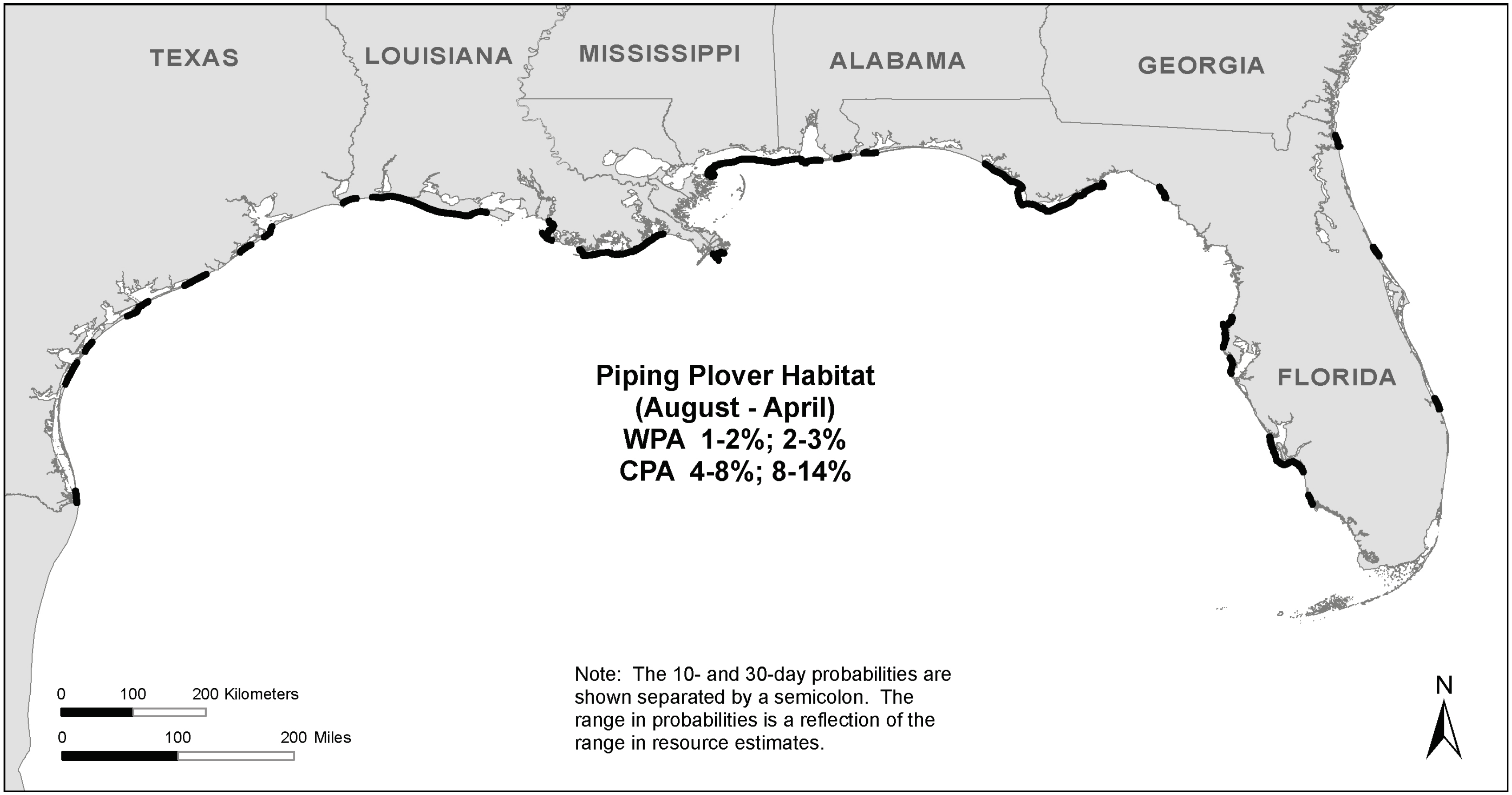

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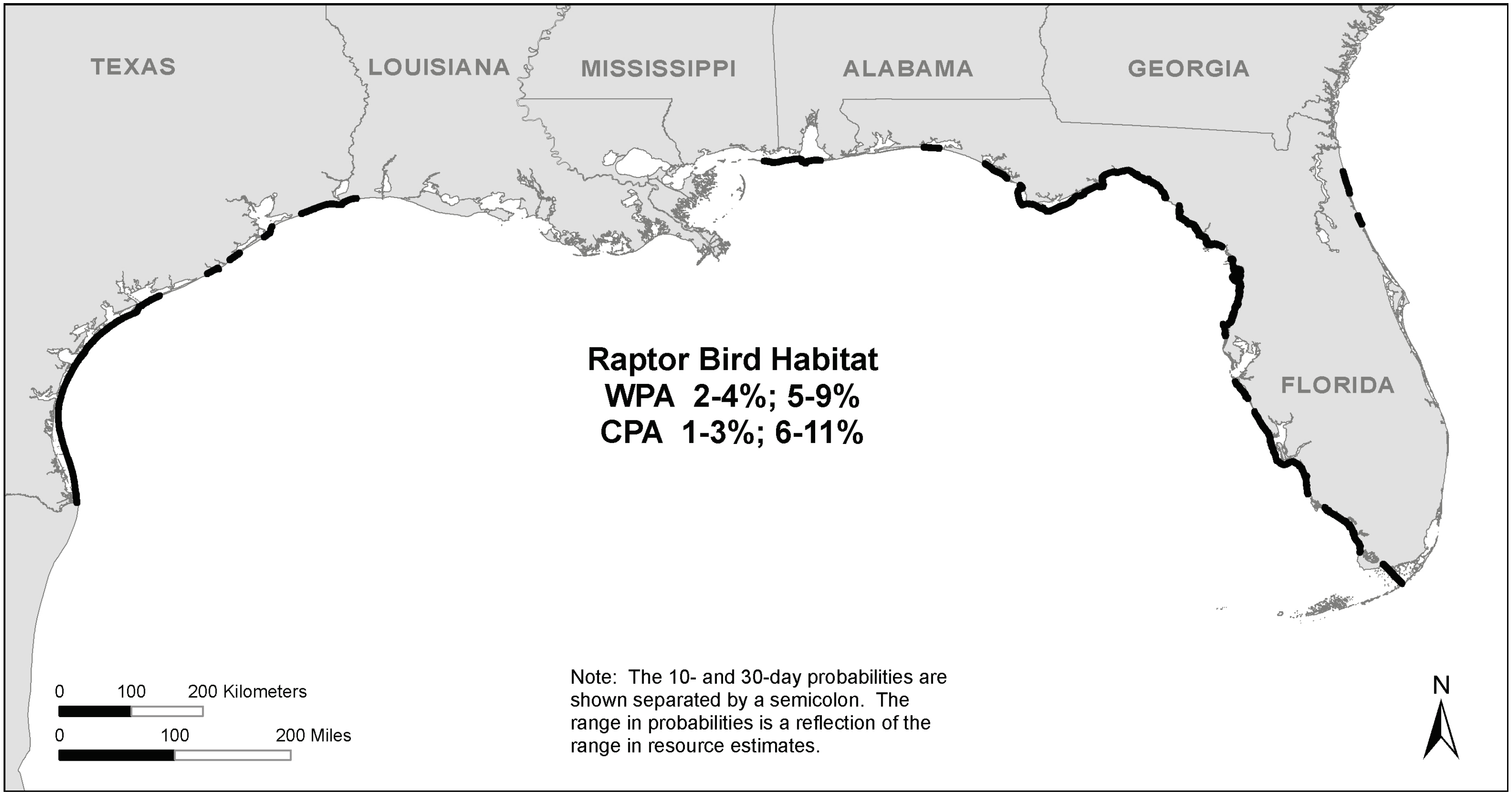

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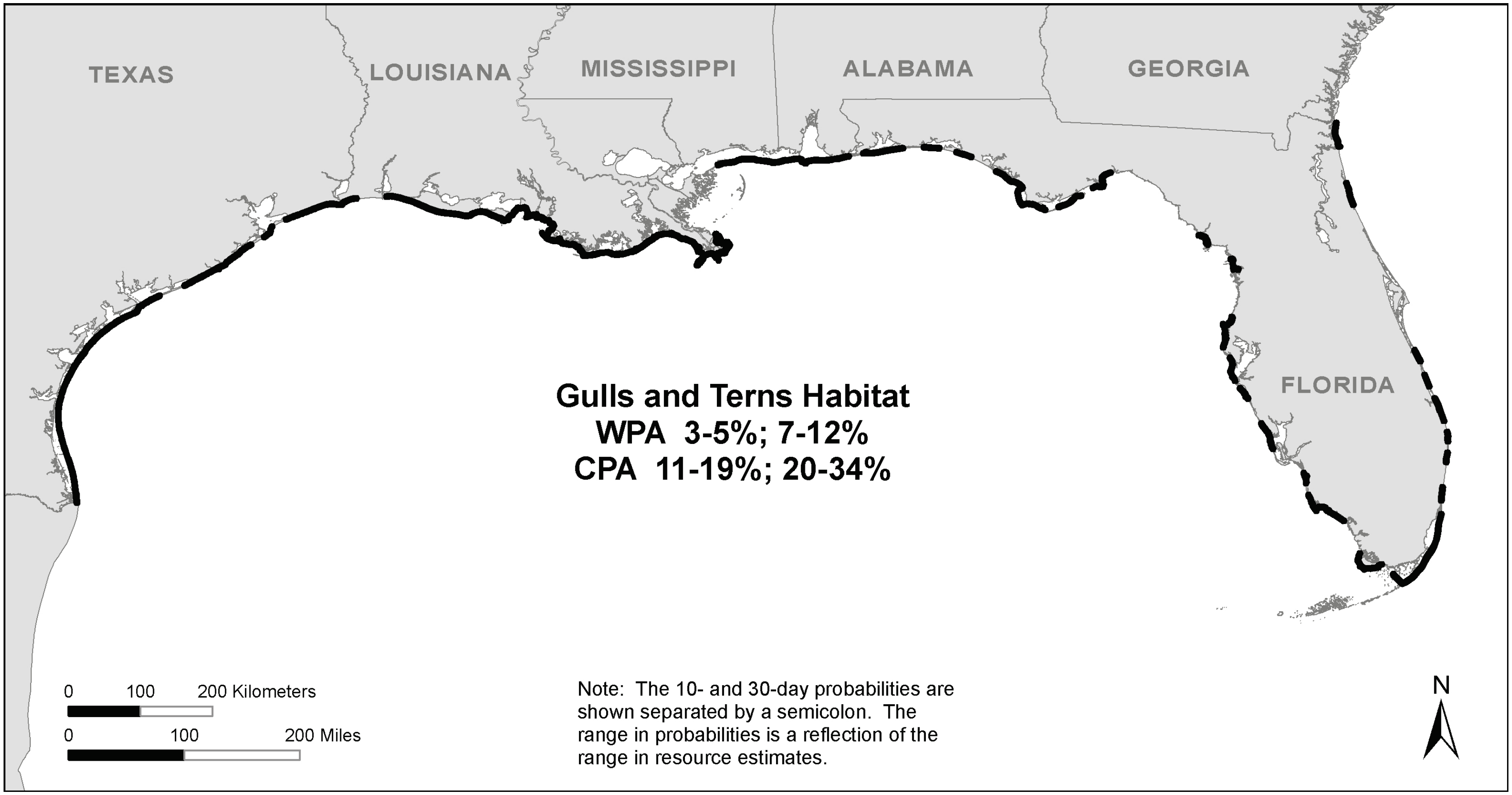

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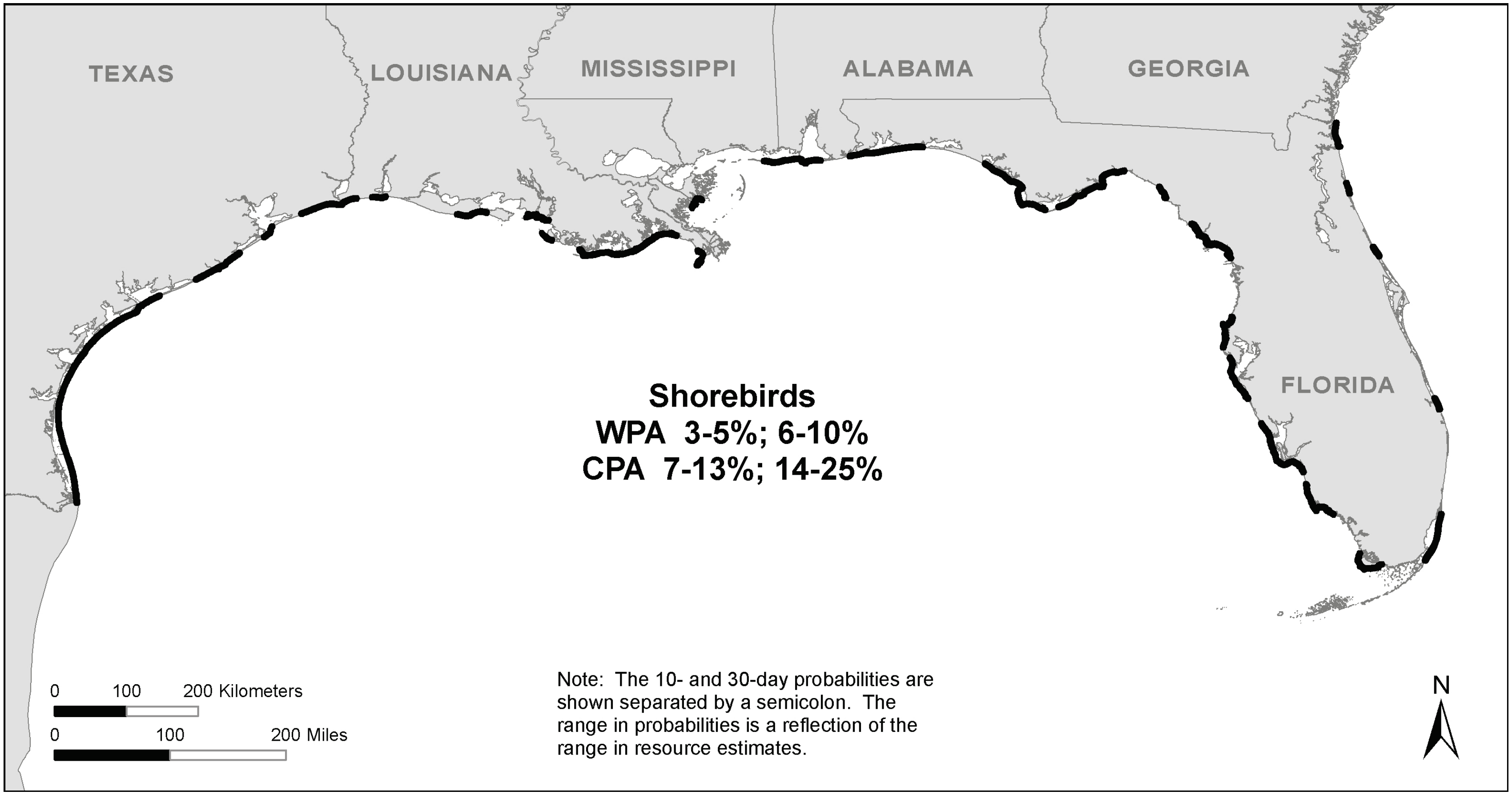

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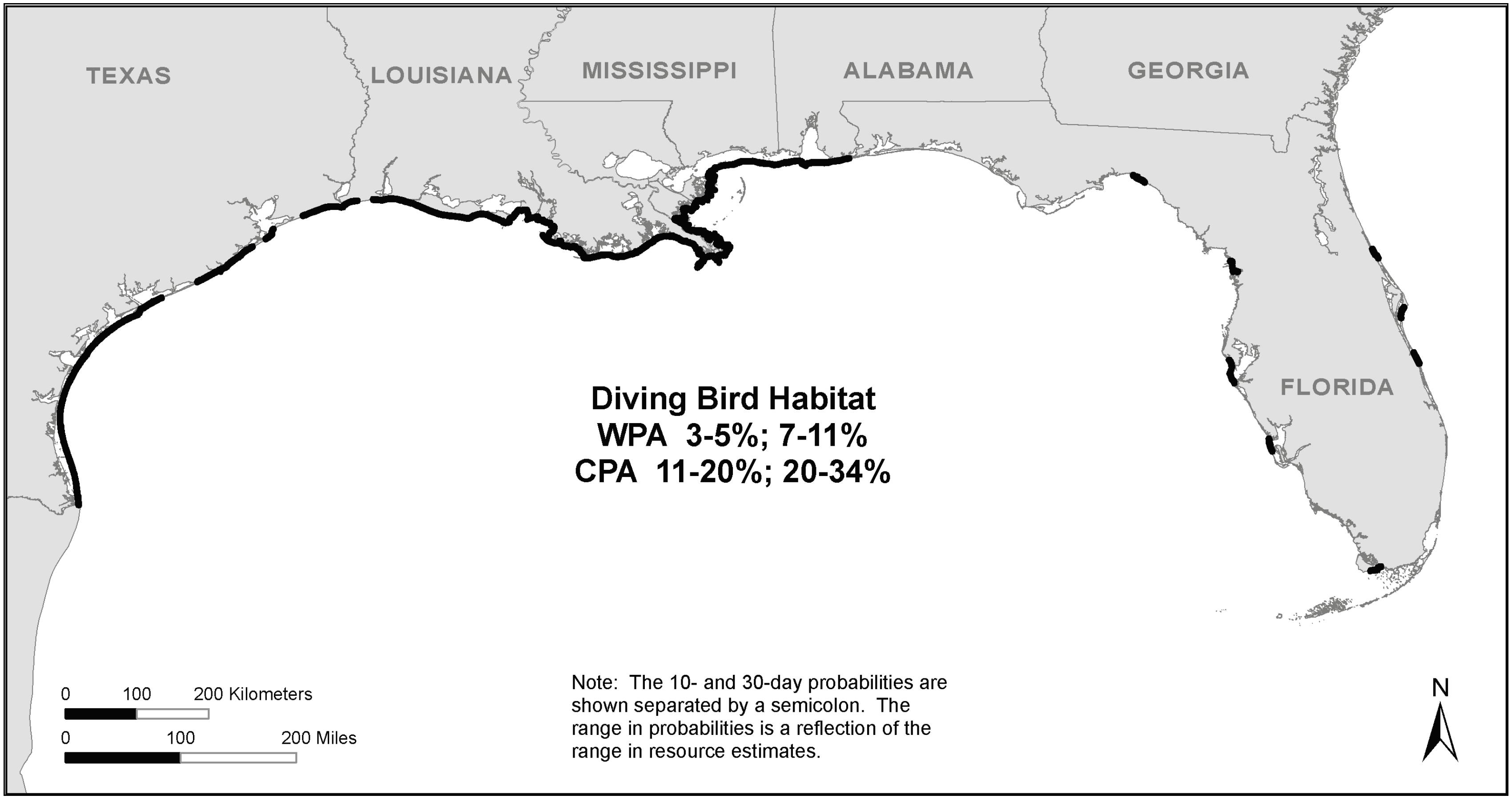

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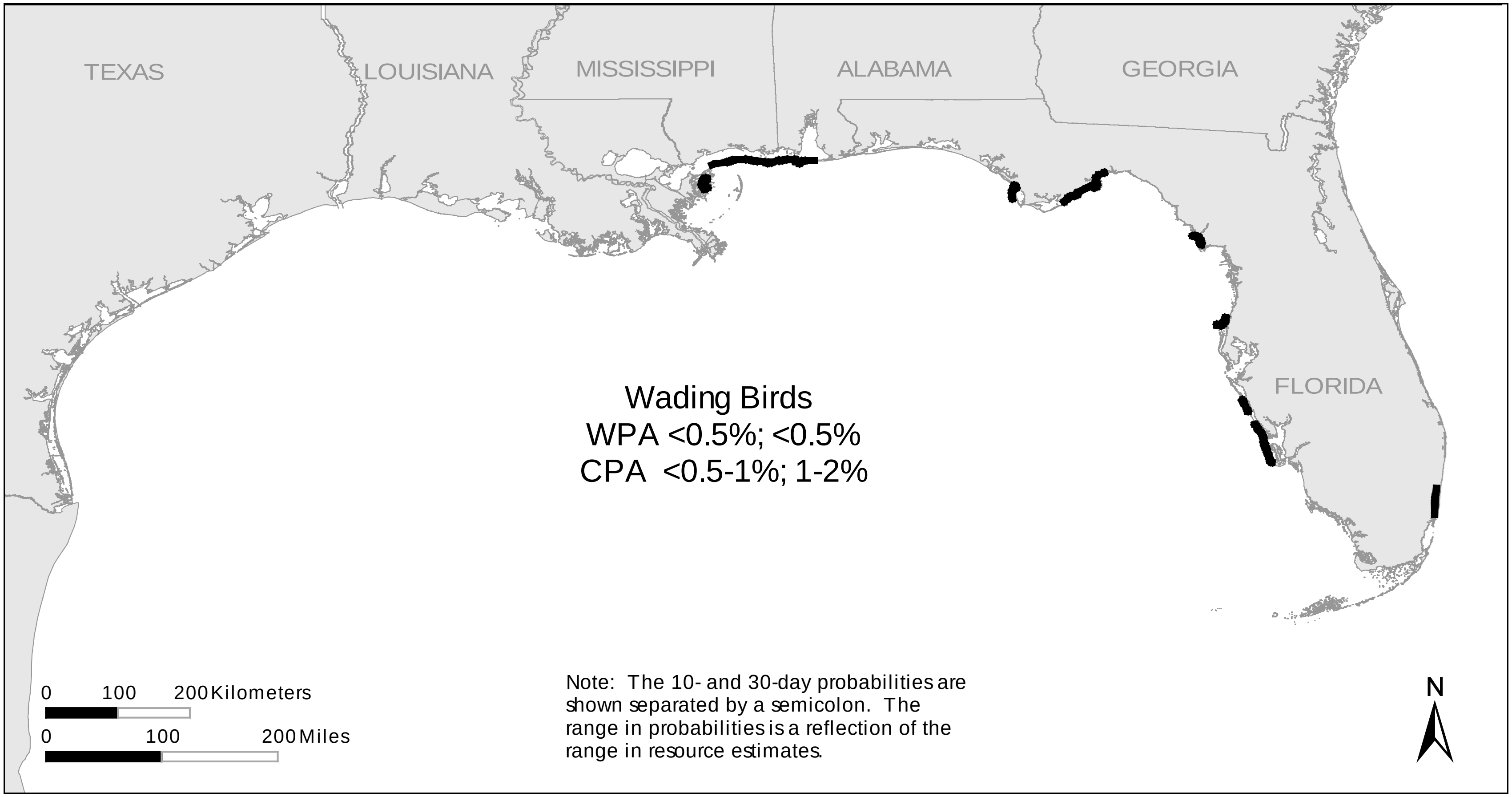

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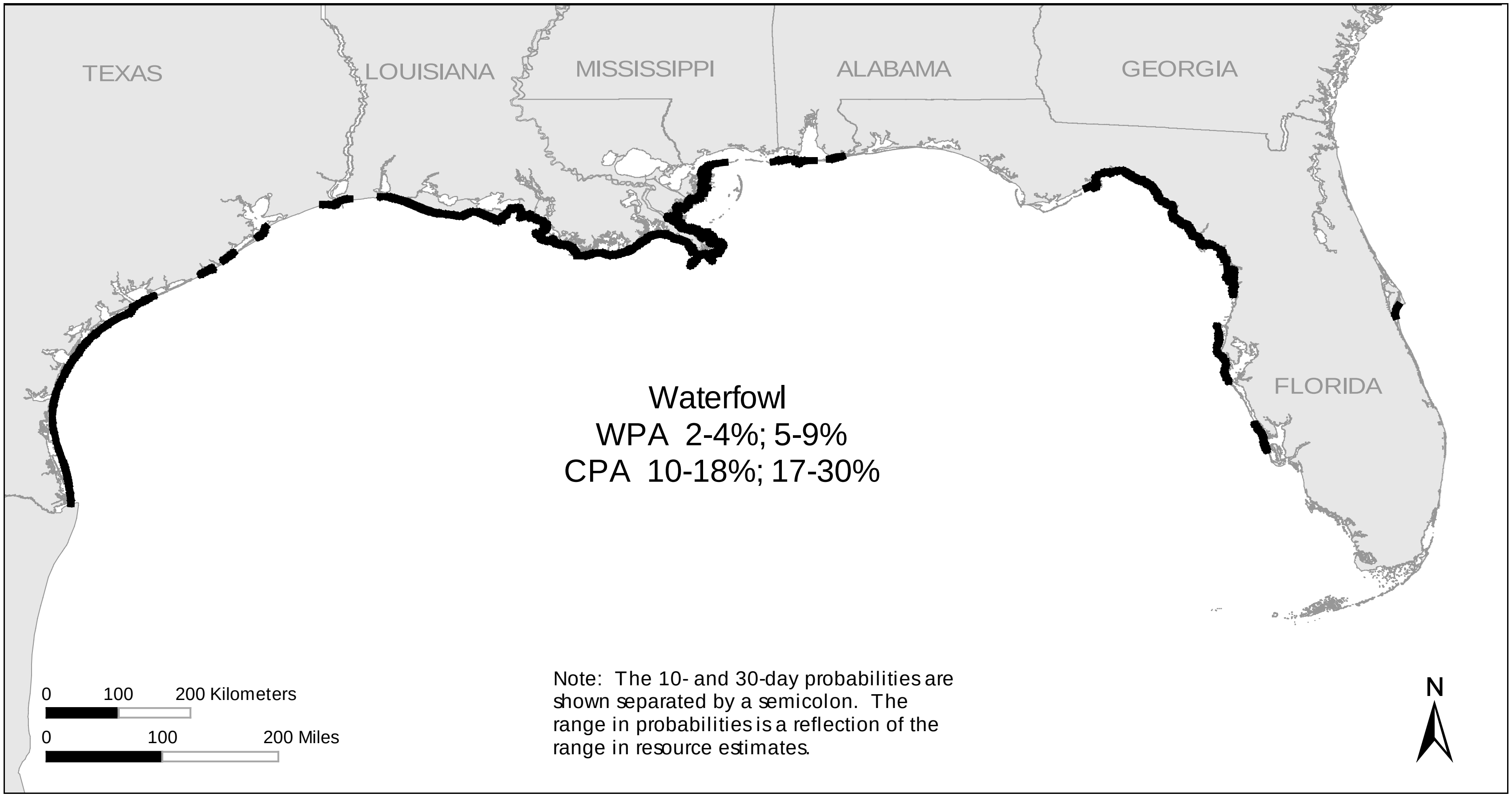

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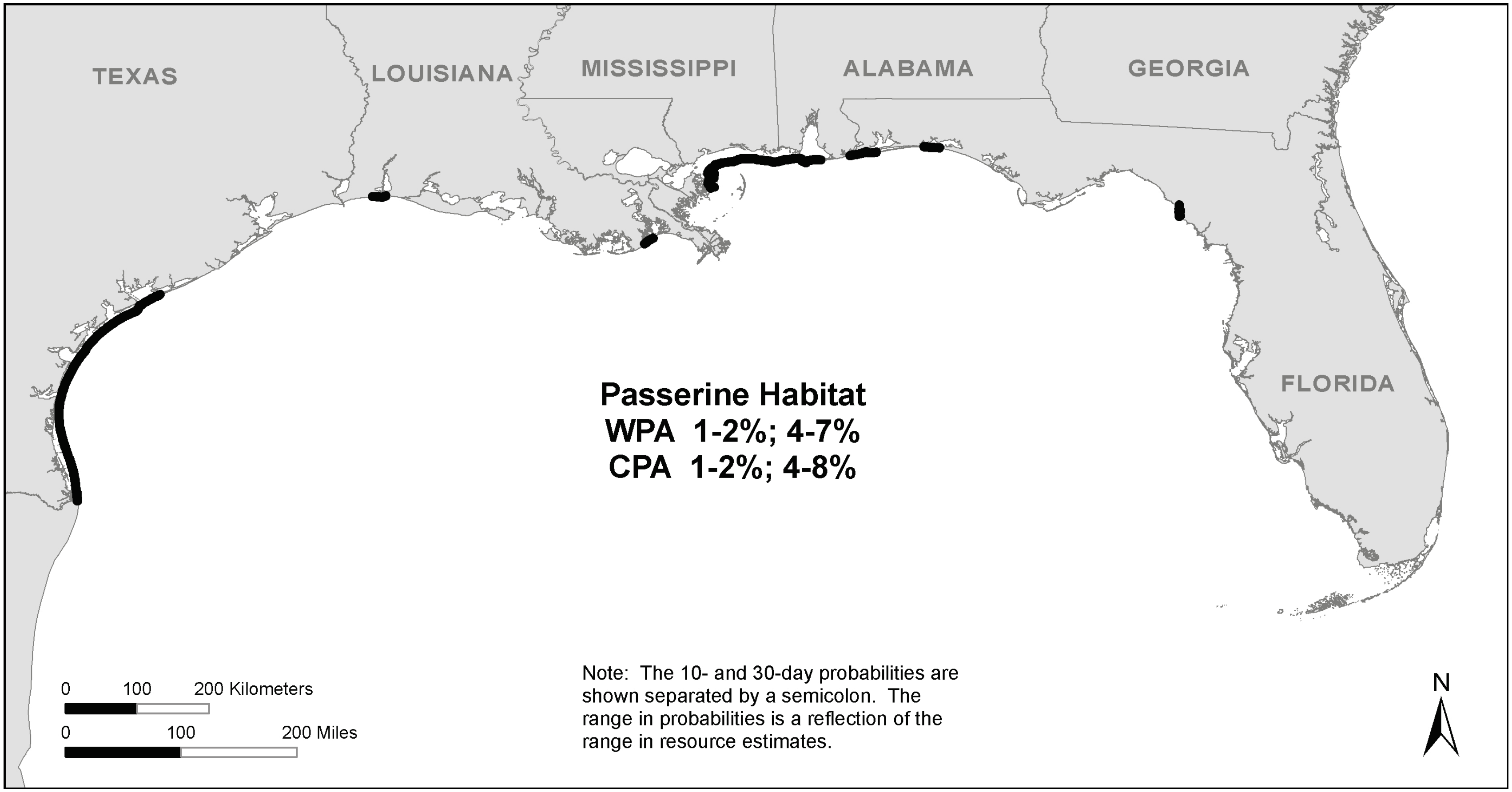

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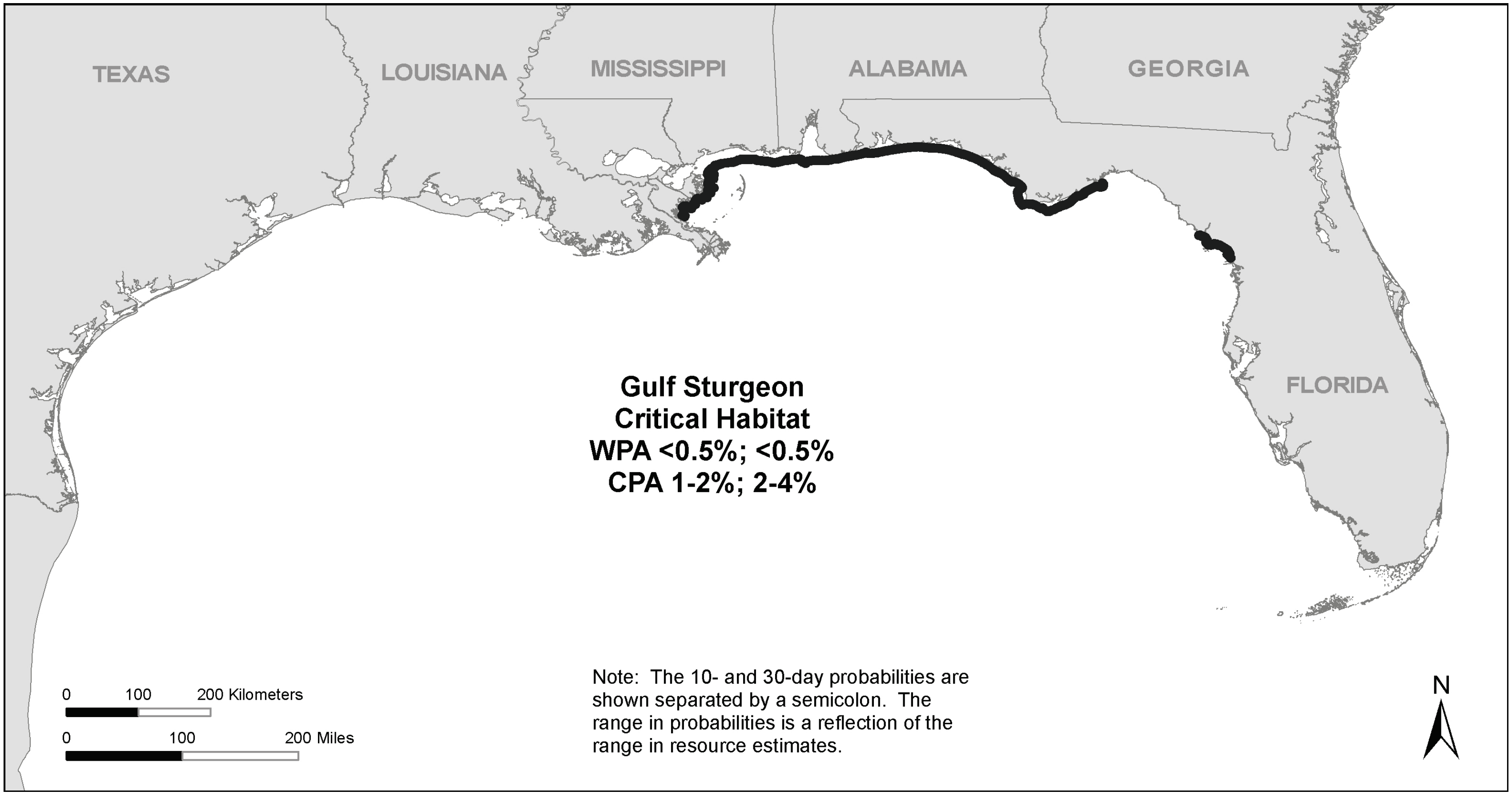

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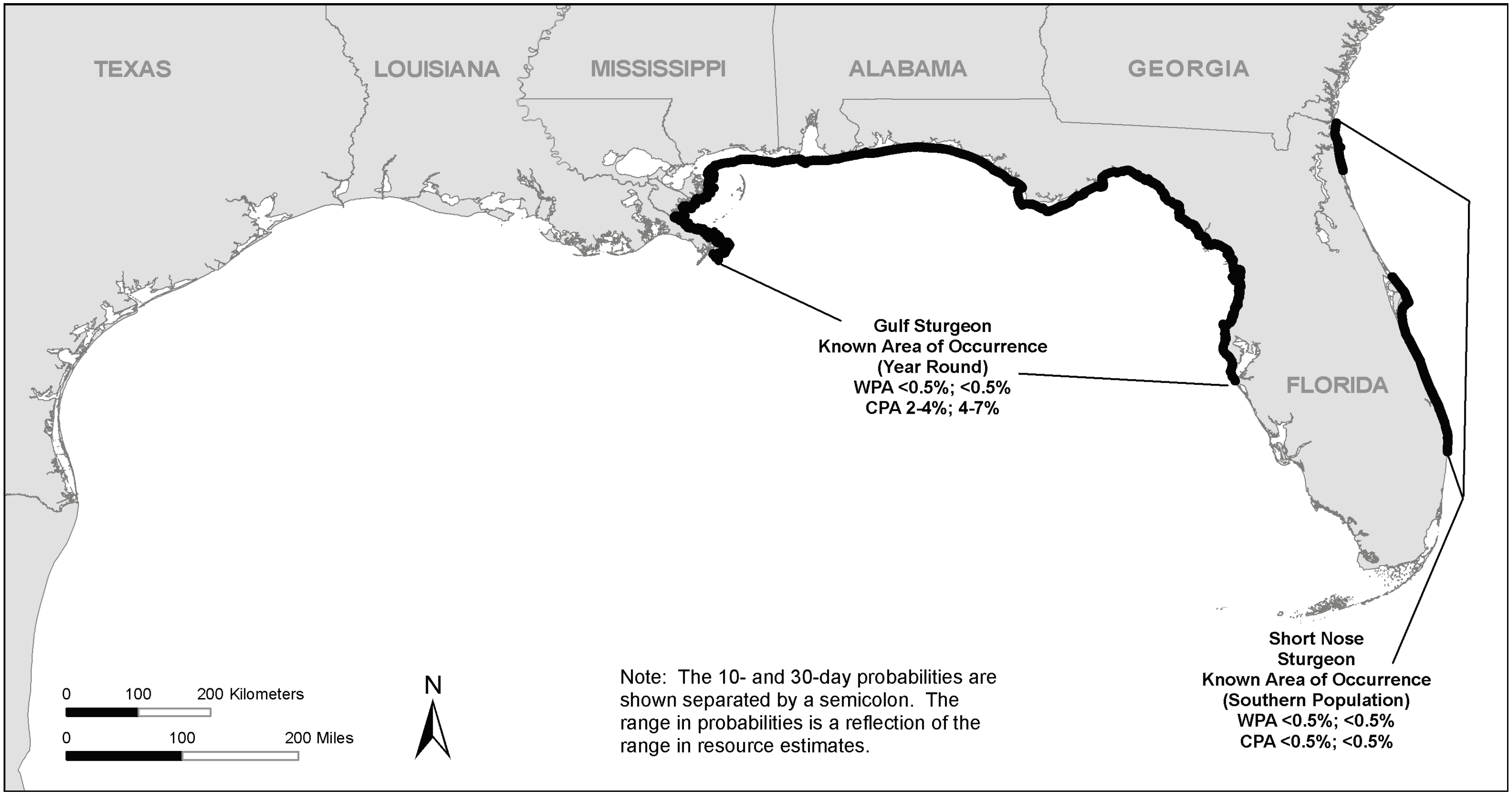

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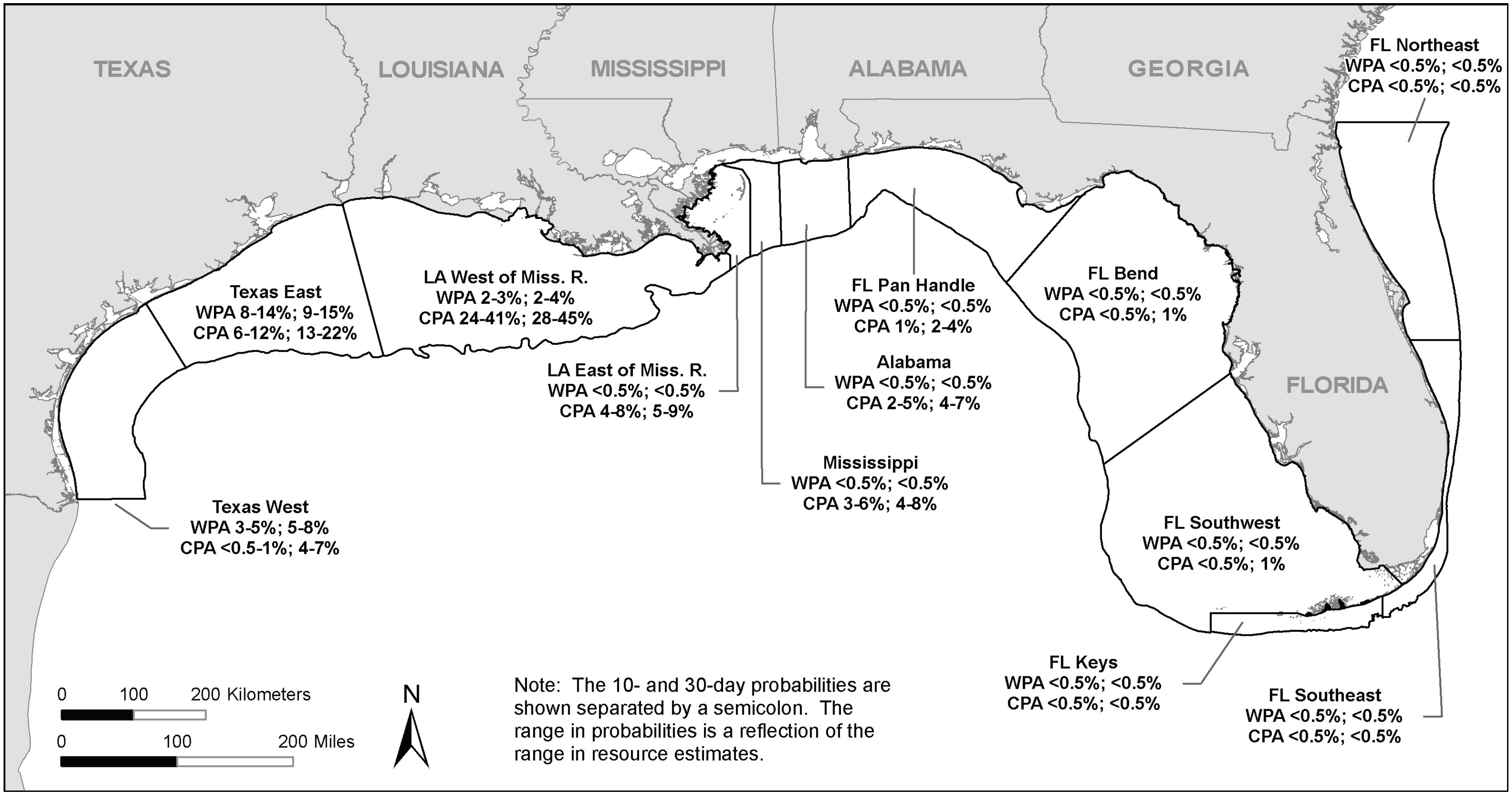

Figure 3-24. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Essential Fish Habitat as a Result of a WPA or CPA Proposed Action.

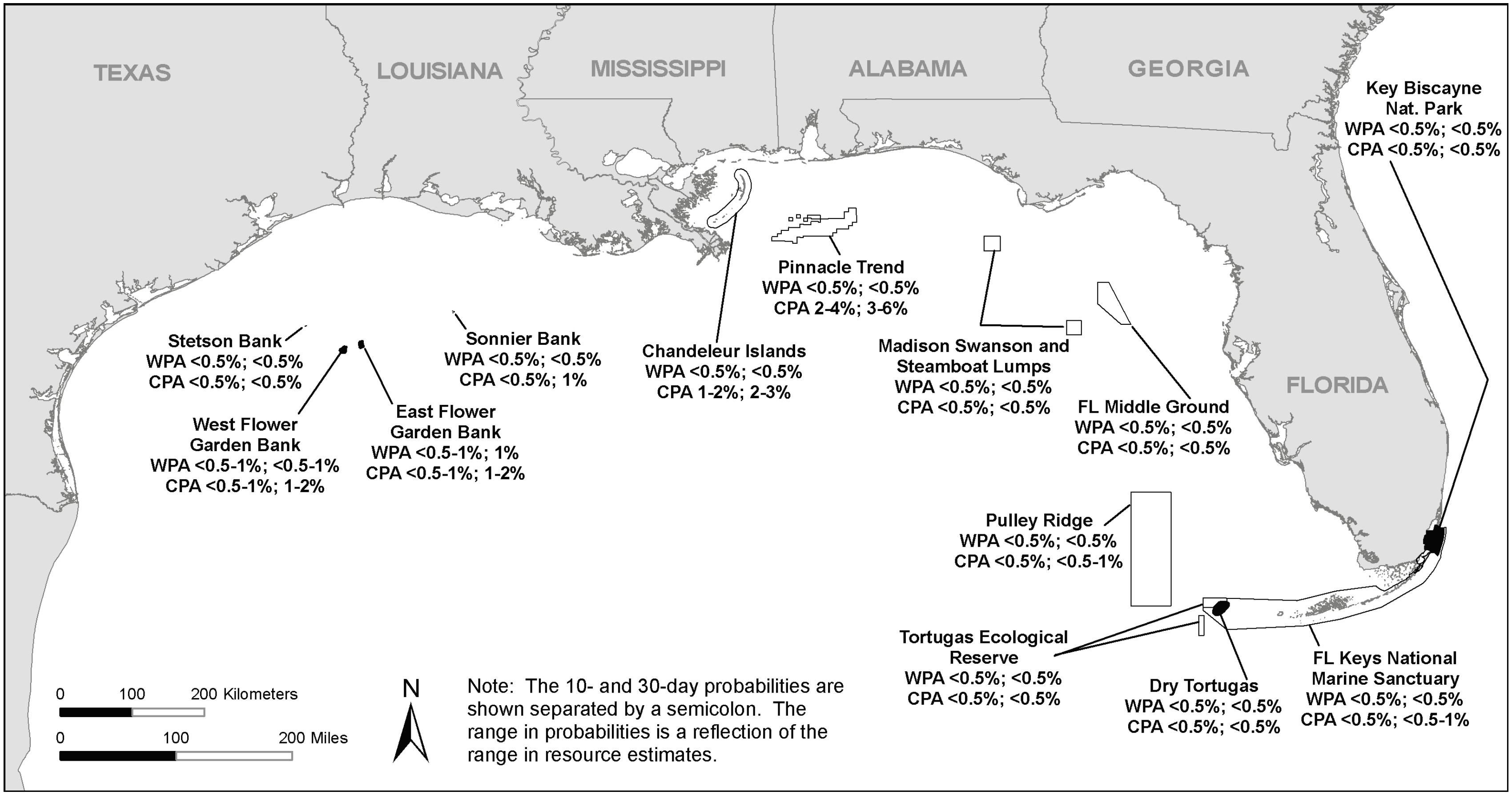

Figure 3-25. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days the Surface Waters Overlying and Surrounding Offshore Environmental Features or Boundary Targets as a Result of a WPA or CPA Proposed Action.

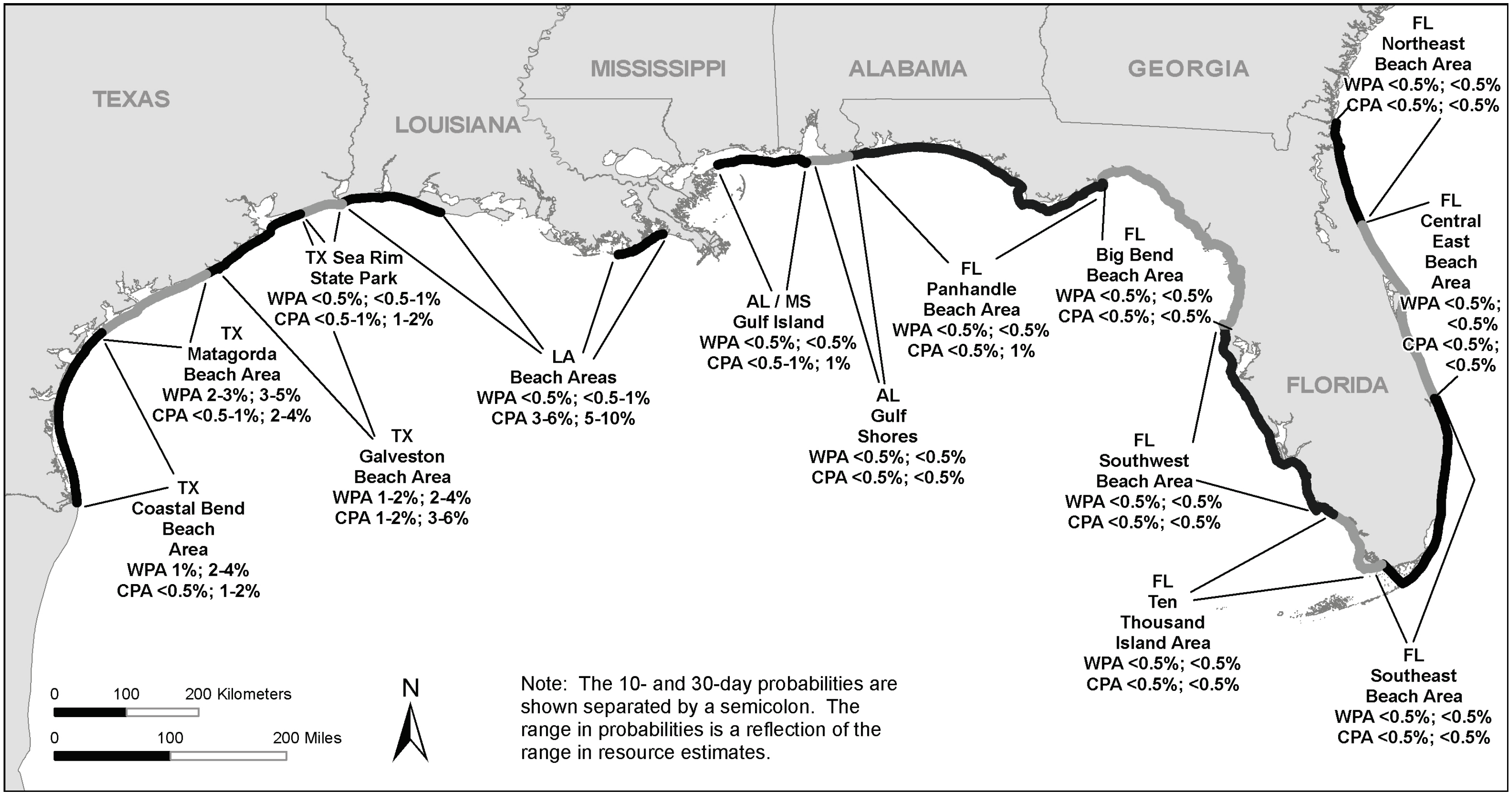

Figure 3-26. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Recreational Beaches as a Result of a WPA or CPA Proposed Action.

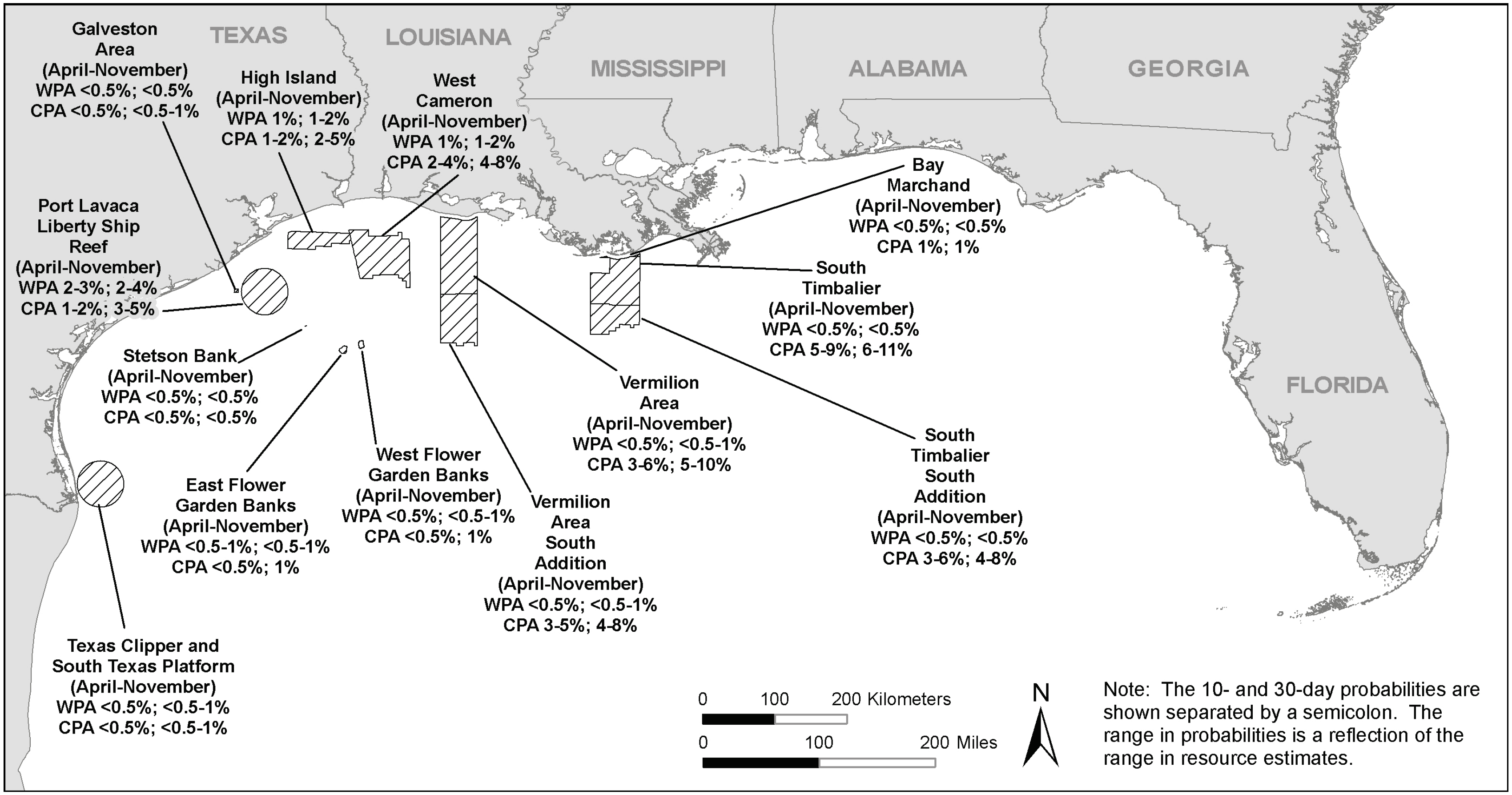

Figure 3-27. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Recreational Dive Sites (in the western Gulf of Mexico) as a Result of a WPA or CPA Proposed Action.

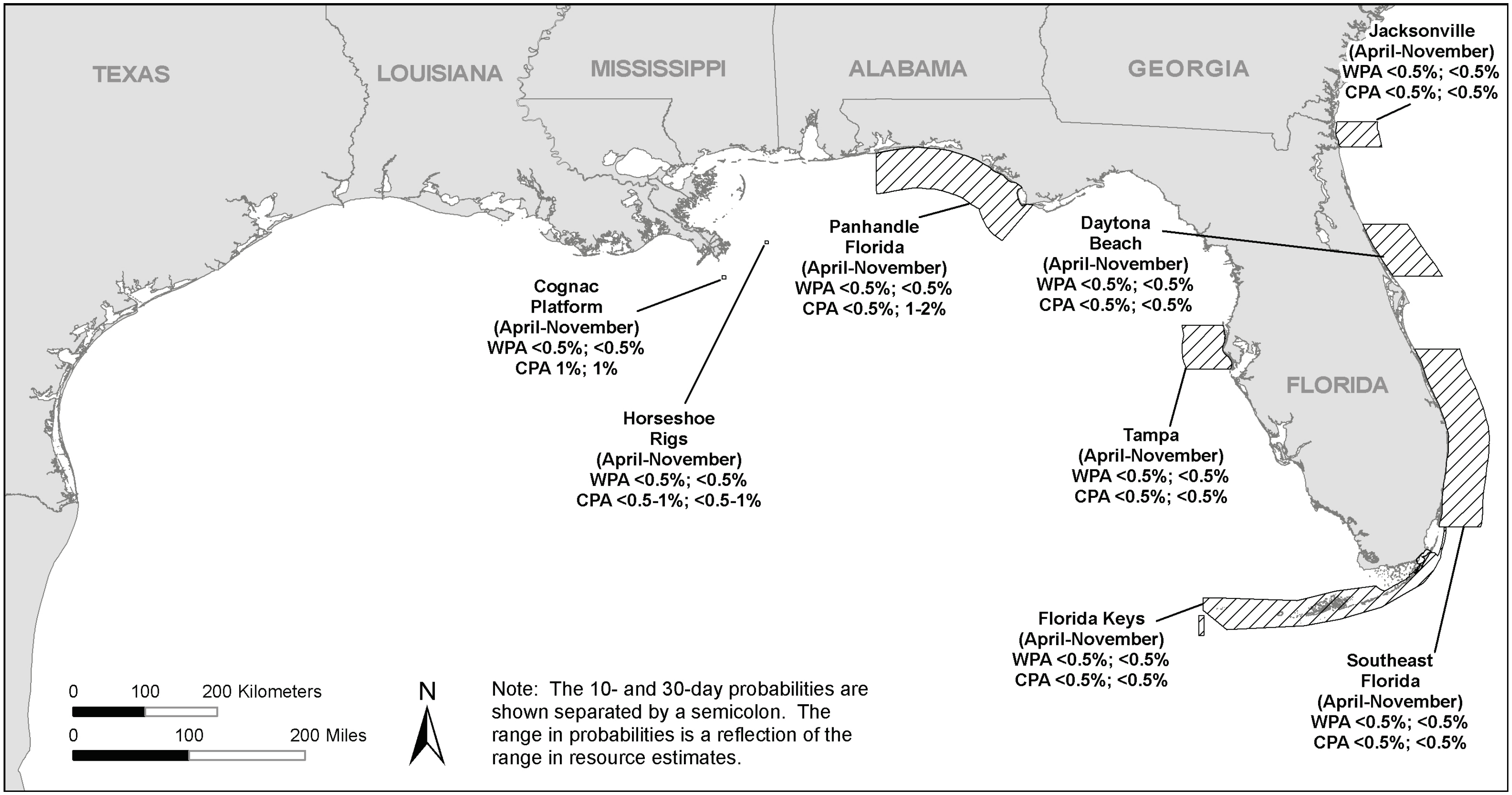

Figure 3-28. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Recreational Dive Sites (in the eastern Gulf of Mexico and eastern Florida shelf waters) as a Result of a WPA or CPA Proposed Action.

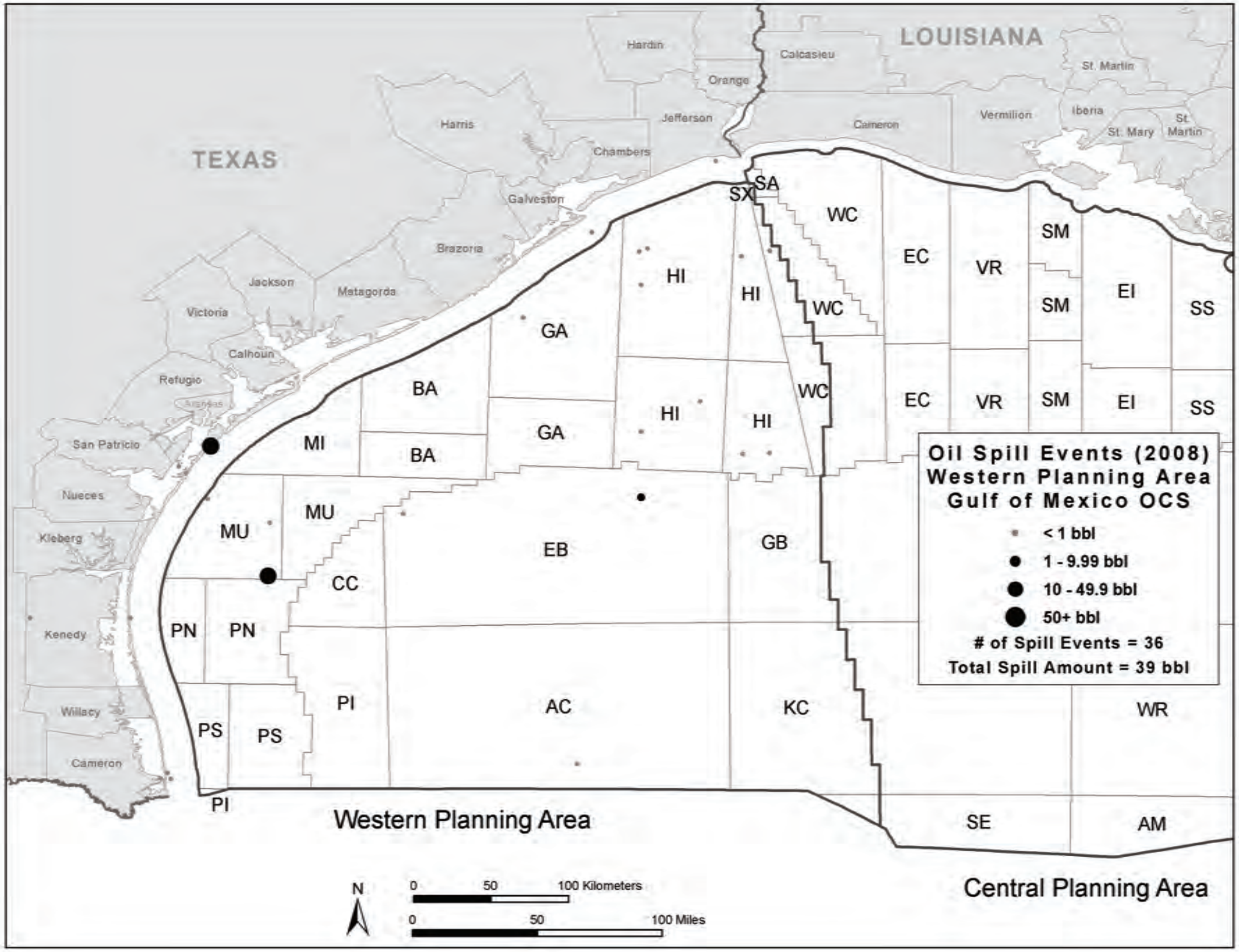

Figure 3-29. Oil-Spill Events (2008) in the Western Planning Area (Dickey, official communication, 2010).

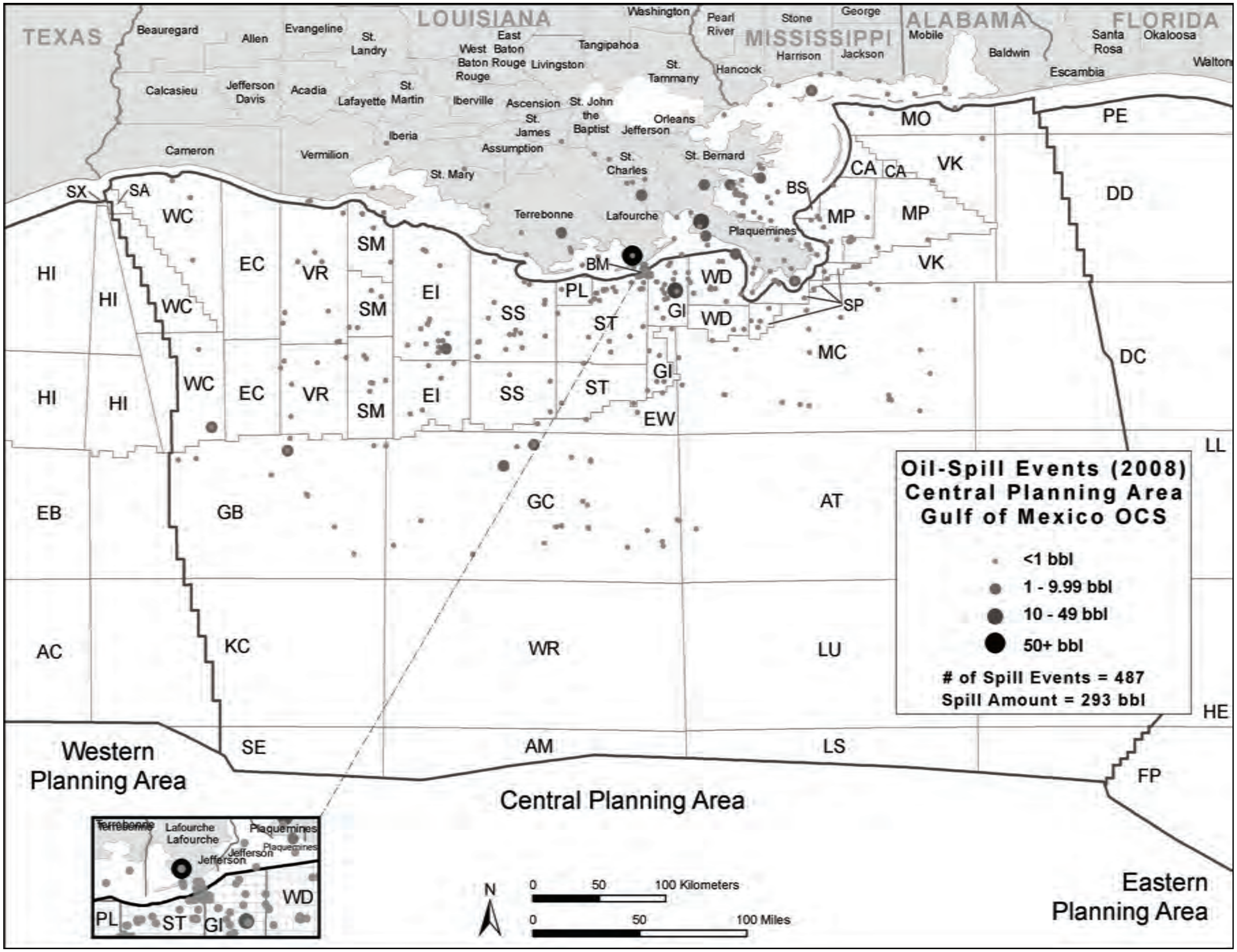

Figure 3-30. Oil-Spill Events (2008) in the Central Planning Area (Dickey, official communication, 2010).

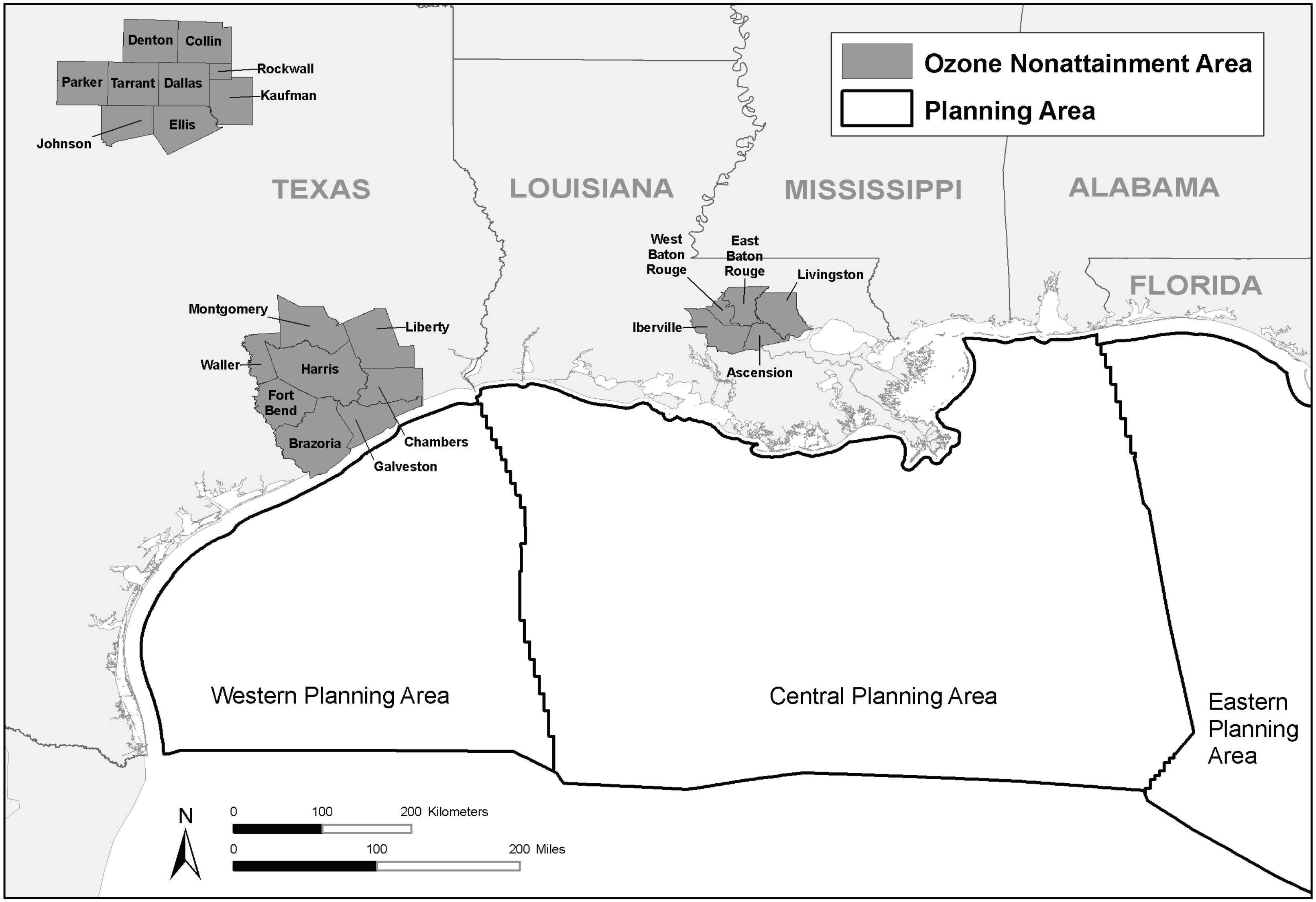

Figure 4-1. Status of Ozone Nonattainment in the Coastal and Inland Counties and Parishes of the Western and Central Planning Areas (USEPA, 2011).

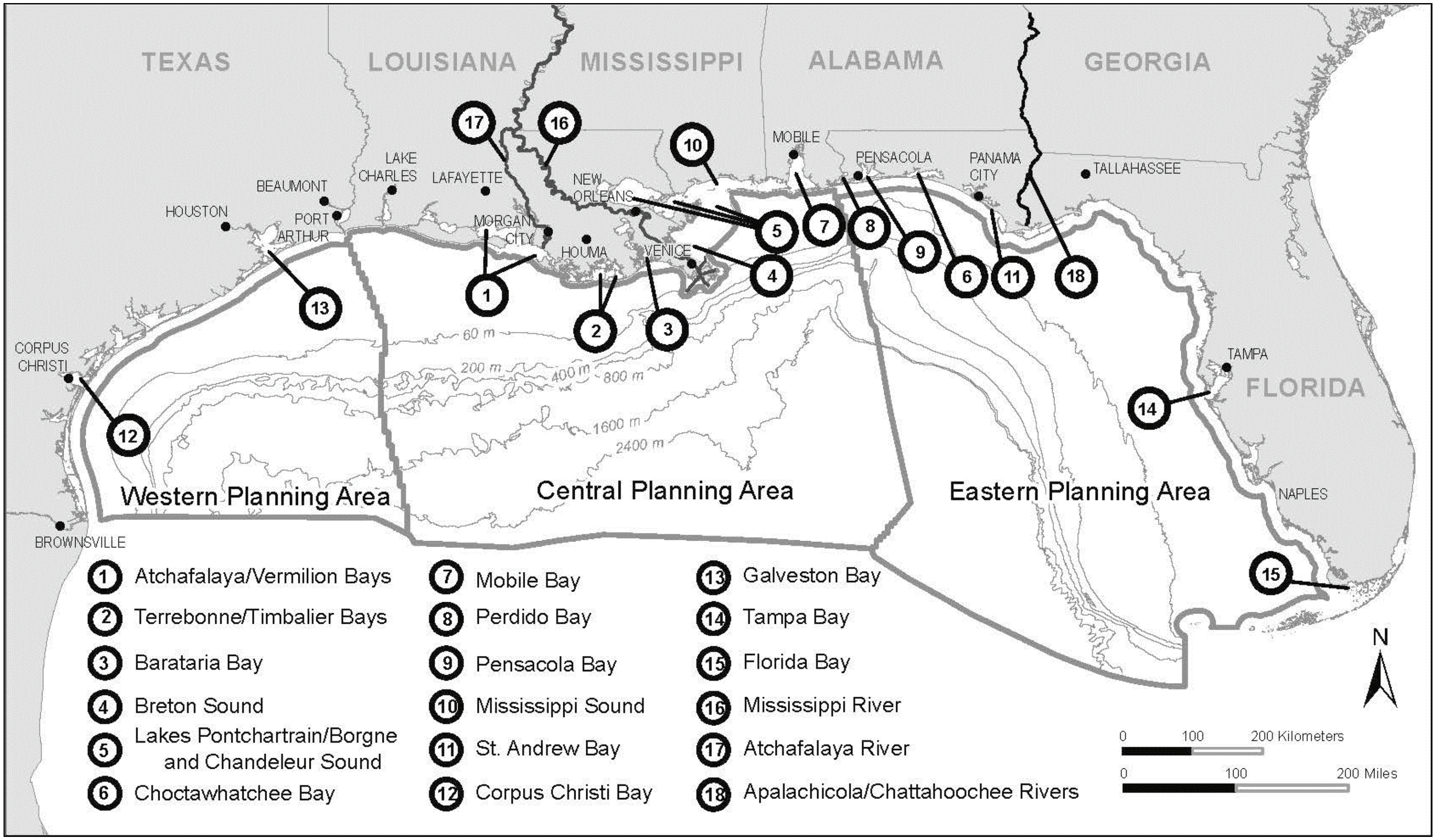

Figure 4-2. Coastal and Offshore Waters of the Gulf of Mexico with Selected Waterbodies.

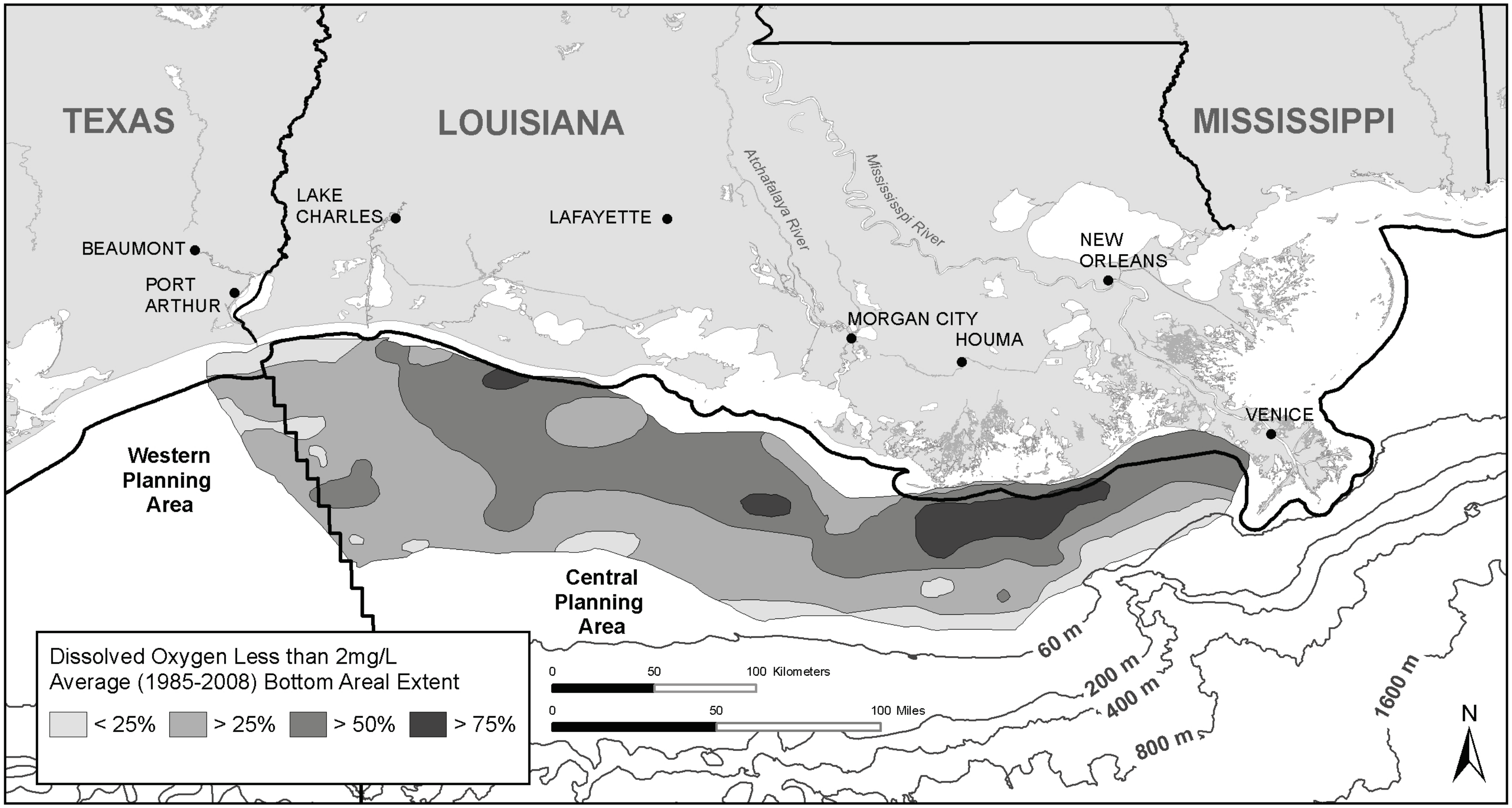

Figure 4-3. Occurrence of Hypoxia in the Gulf of Mexico (Rabalais and Turner, 2011).

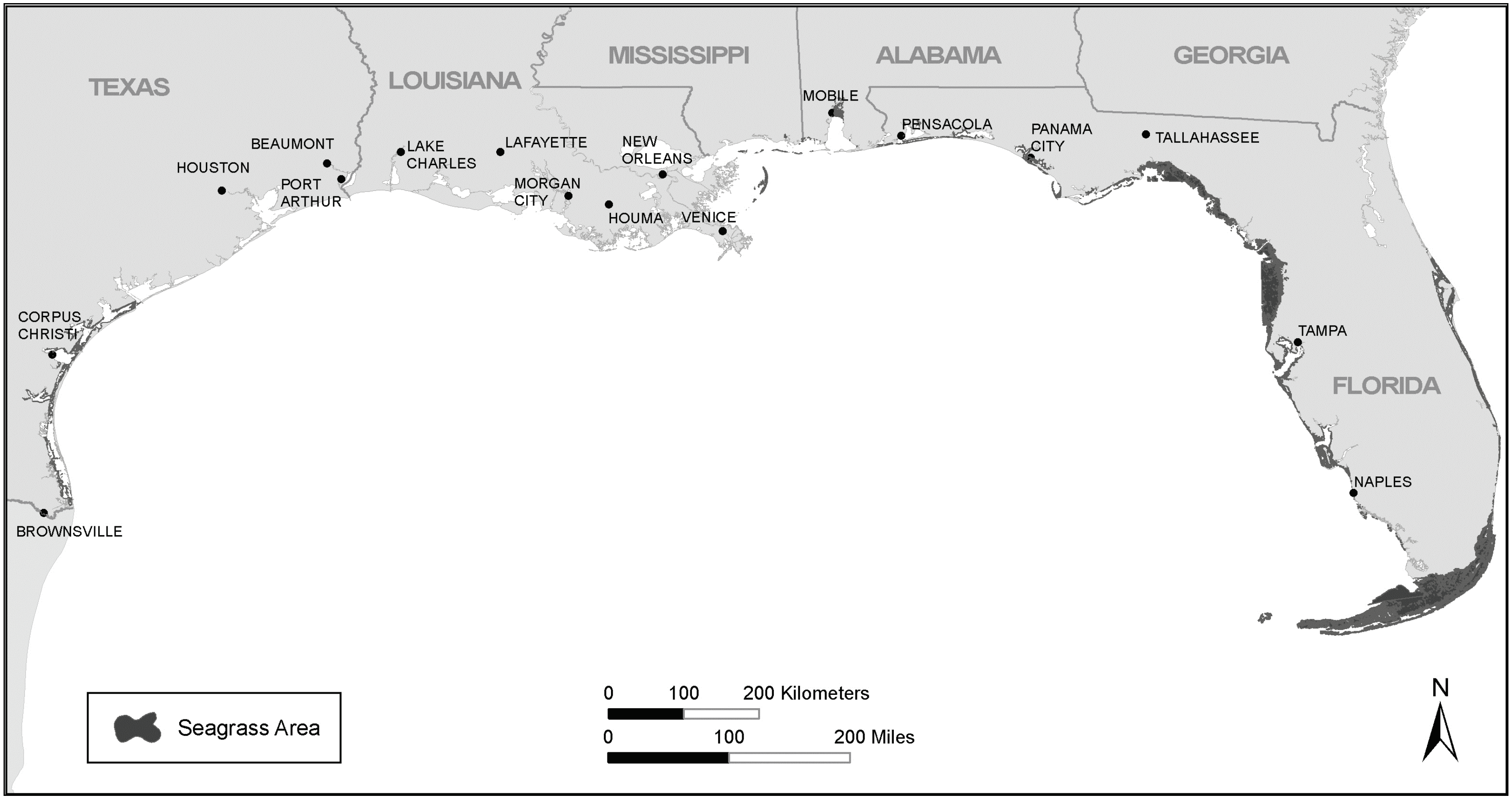

Figure 4-4. Seagrass Locations of the Northern Gulf of Mexico.

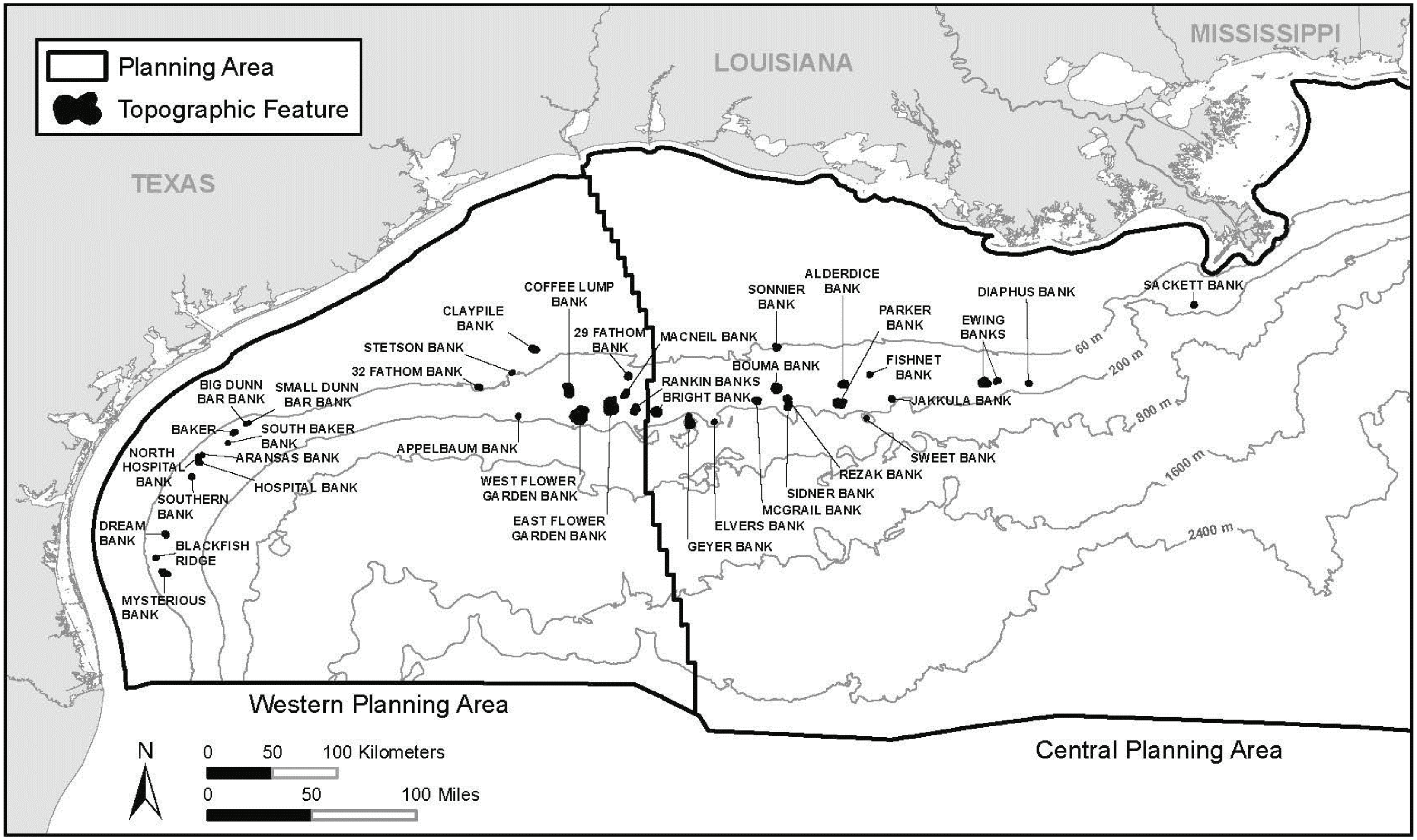

Figure 4-5. Location of Topographic Features in the Gulf of Mexico.

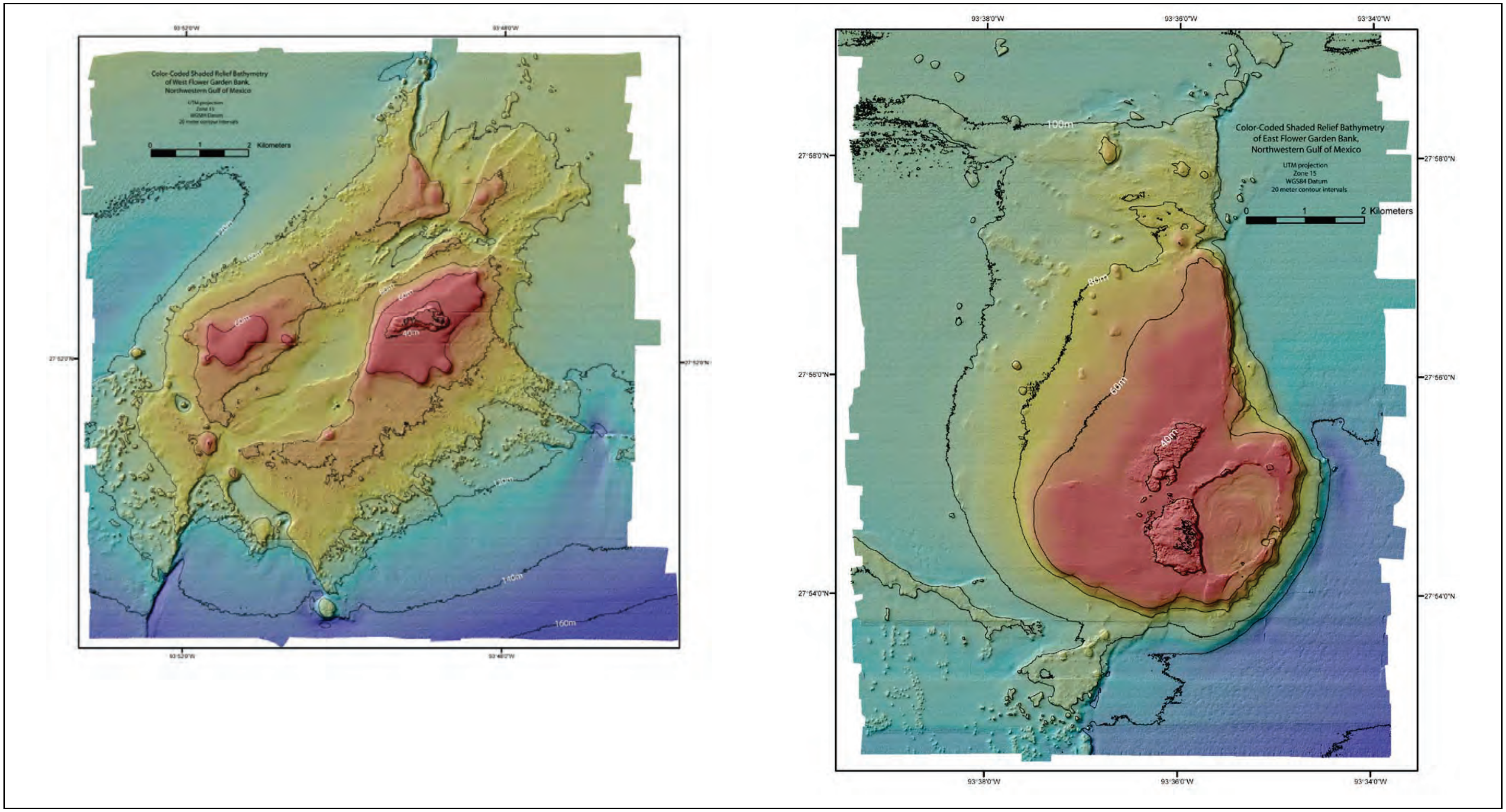

Figure 4-6. Color-Shaded Relief, Multibeam Bathymetric Images of the West and East Flower Garden Banks (USDOI, GS, 2008; reproduced from Gardner et al., 1998).

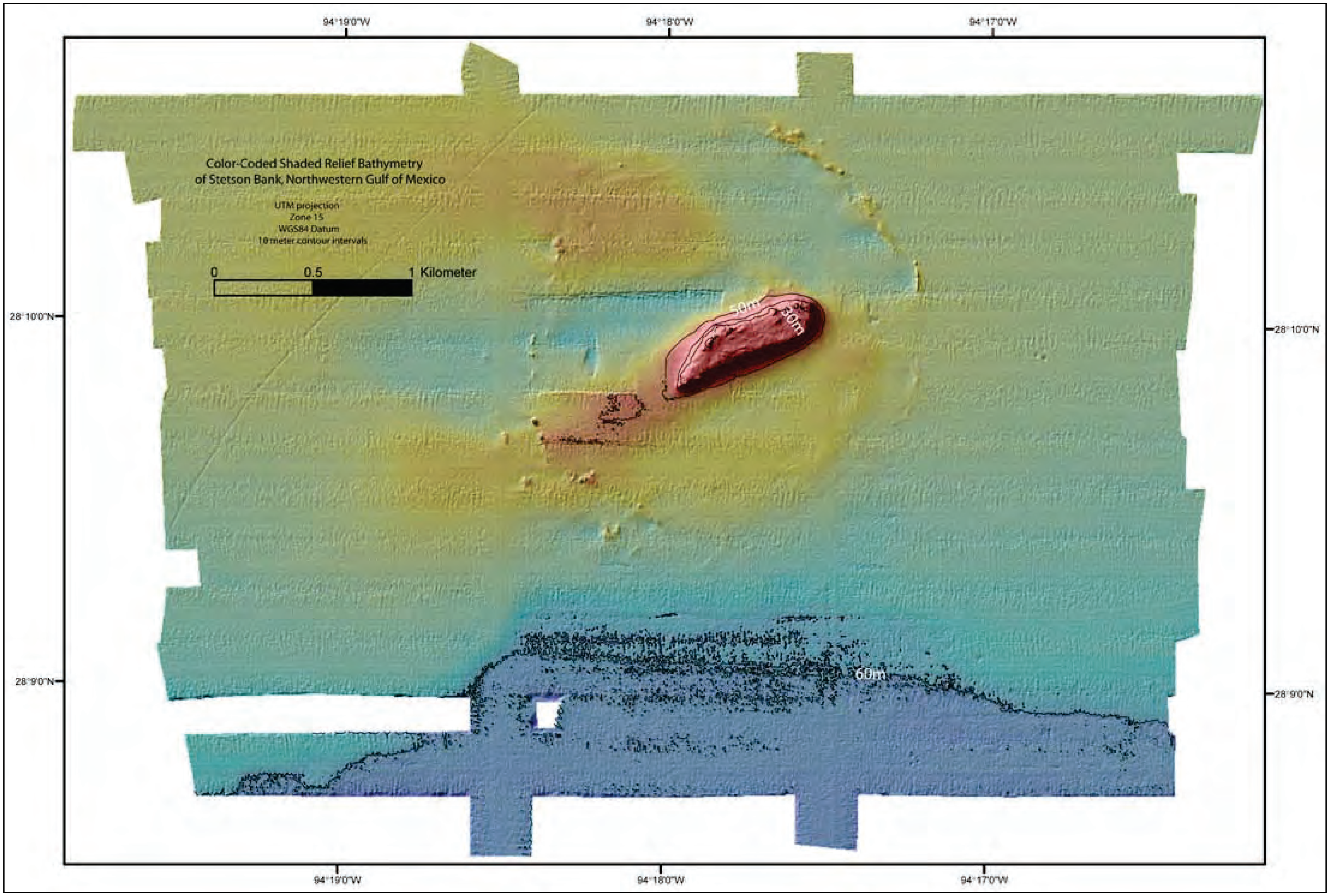

Figure 4-7. Color-Shaded, Multibeam Bathymetric Topographic Image of Stetson Bank (USDOI, GS, 2008; reproduced from Gardner et al., 1998).

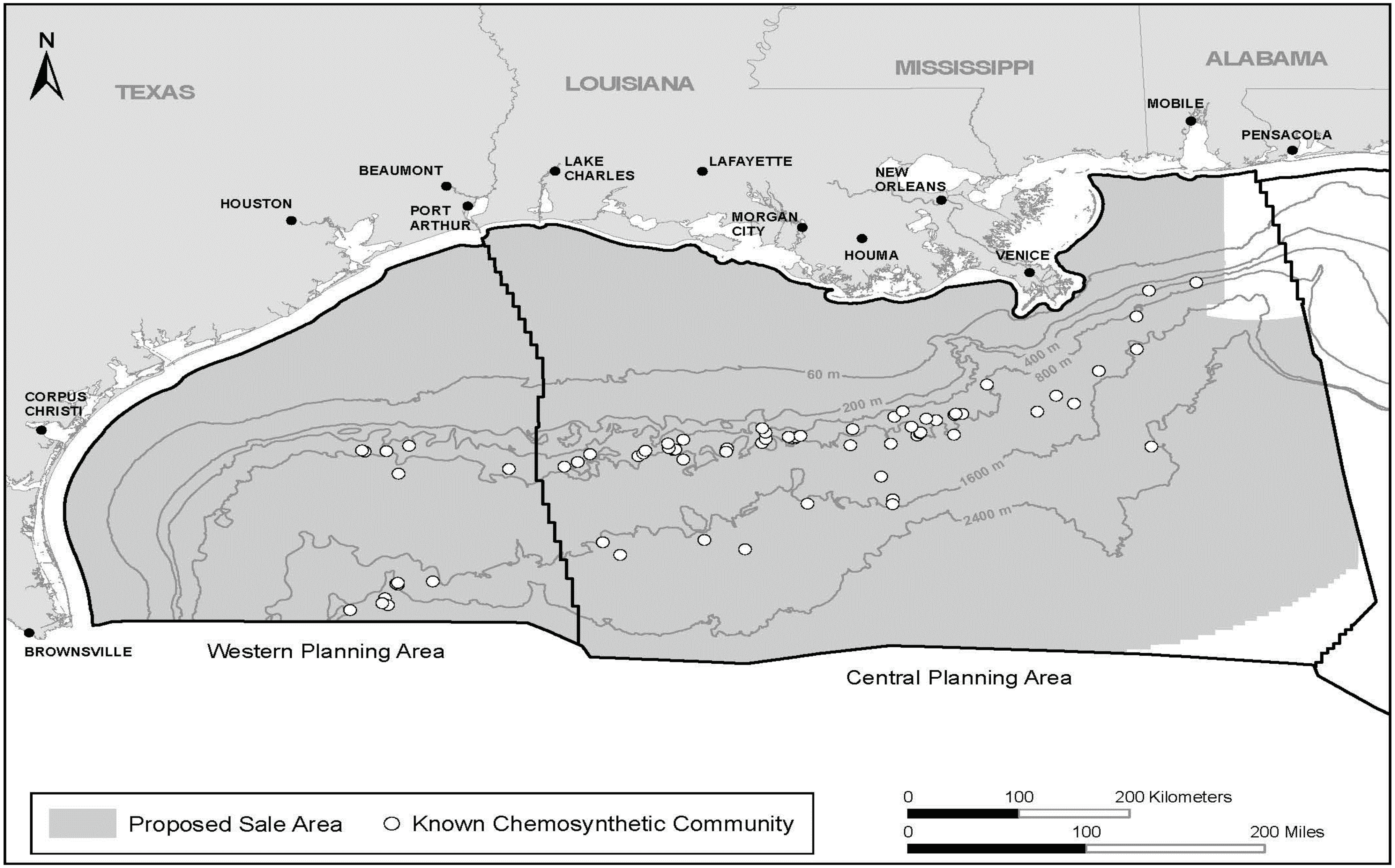

Figure 4-8. Known Chemosynthetic Communities in the Gulf of Mexico. (At least 69 chemosynthetic community sites in the Gulf of Mexico have been visually confirmed through photography, video, and manned submersible dives. These communities typically occur below water depths of 984 ft [300 m] and frequently produce substrate that supports deepwater coral communities.)

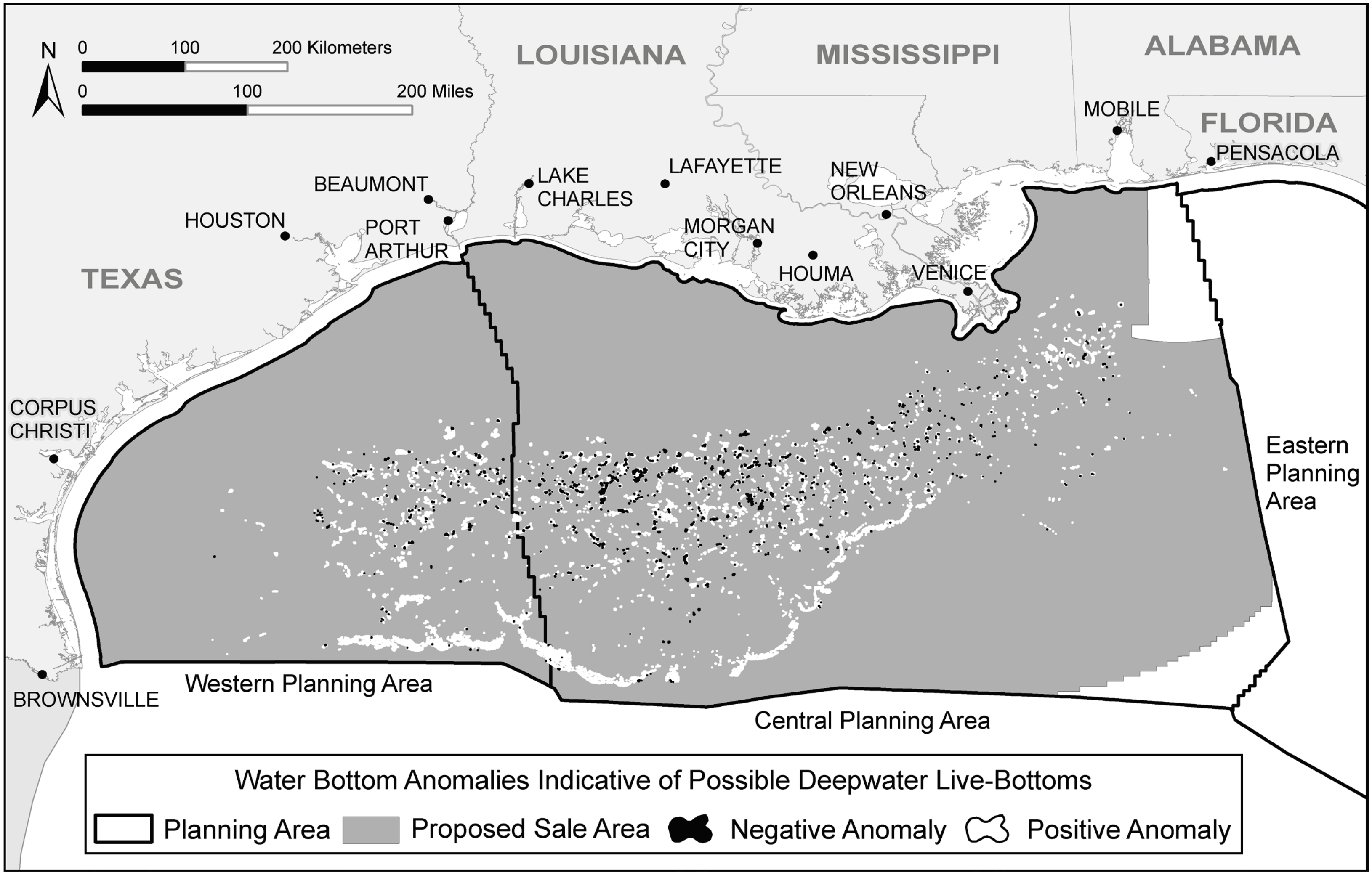

Figure 4-9. Water-Bottom Anomalies Indicative of Possible Deepwater Live Bottoms.

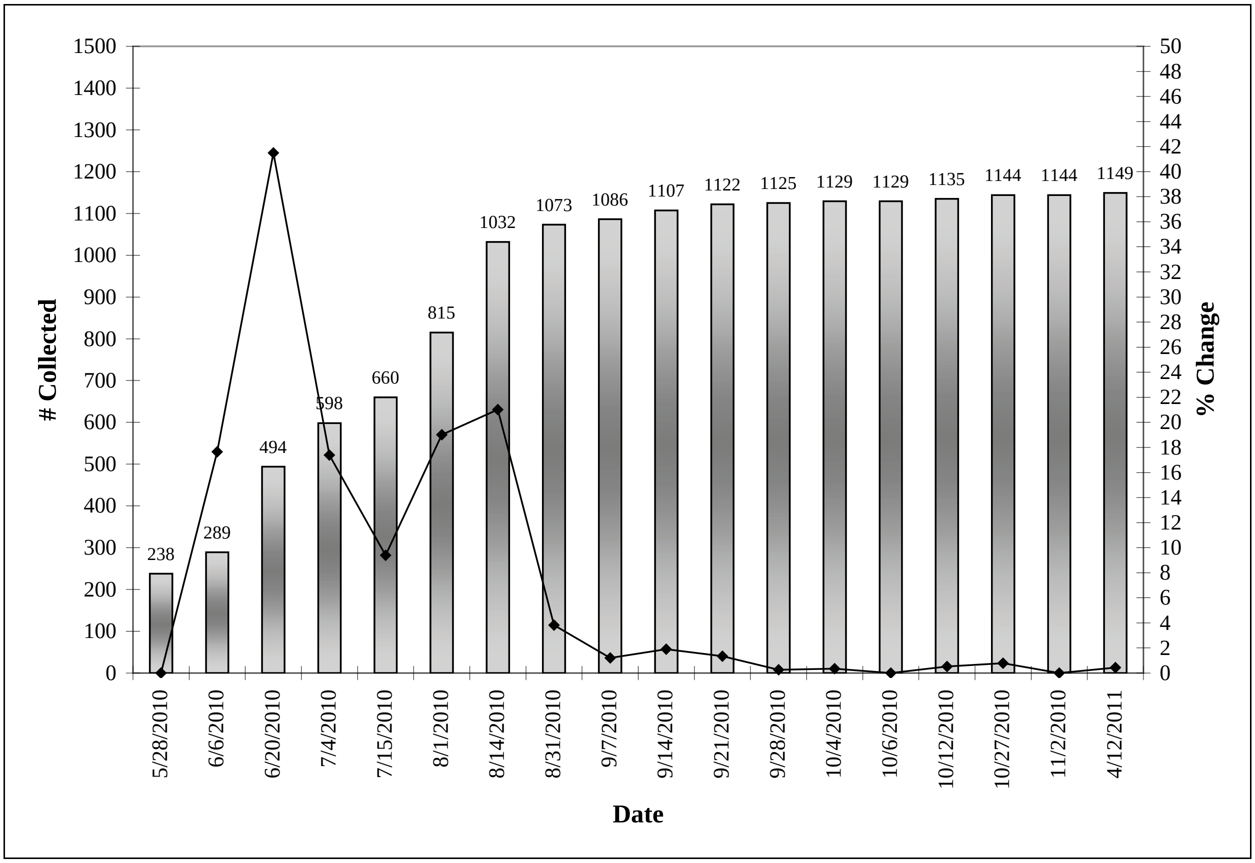

Figure 4-10. Summary of Sea Turtles Collected by Date Obtained from the Consolidated Numbers of Collected Fish and Wildlife That Have Been Reported to the Unified Area Command from the Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Incident Area Commands, Rehabilitation Centers, and Other Authorized Sources Operating within the *Deepwater Horizon*/BP Incident Impact Area through April 12, 2011. (Data on the Y-axis reflect the cumulative number of individual sea turtles collected by date [alive and dead], and data on the Z-axis reflect the proportional change from one reporting date to the next. For the latest available information on oiled or affected sea turtles documented in the area, event response, and daily maps of the current location of spilled oil, see USDOC, NMFS [2011a] and RestoreTheGulf.gov [2011].)

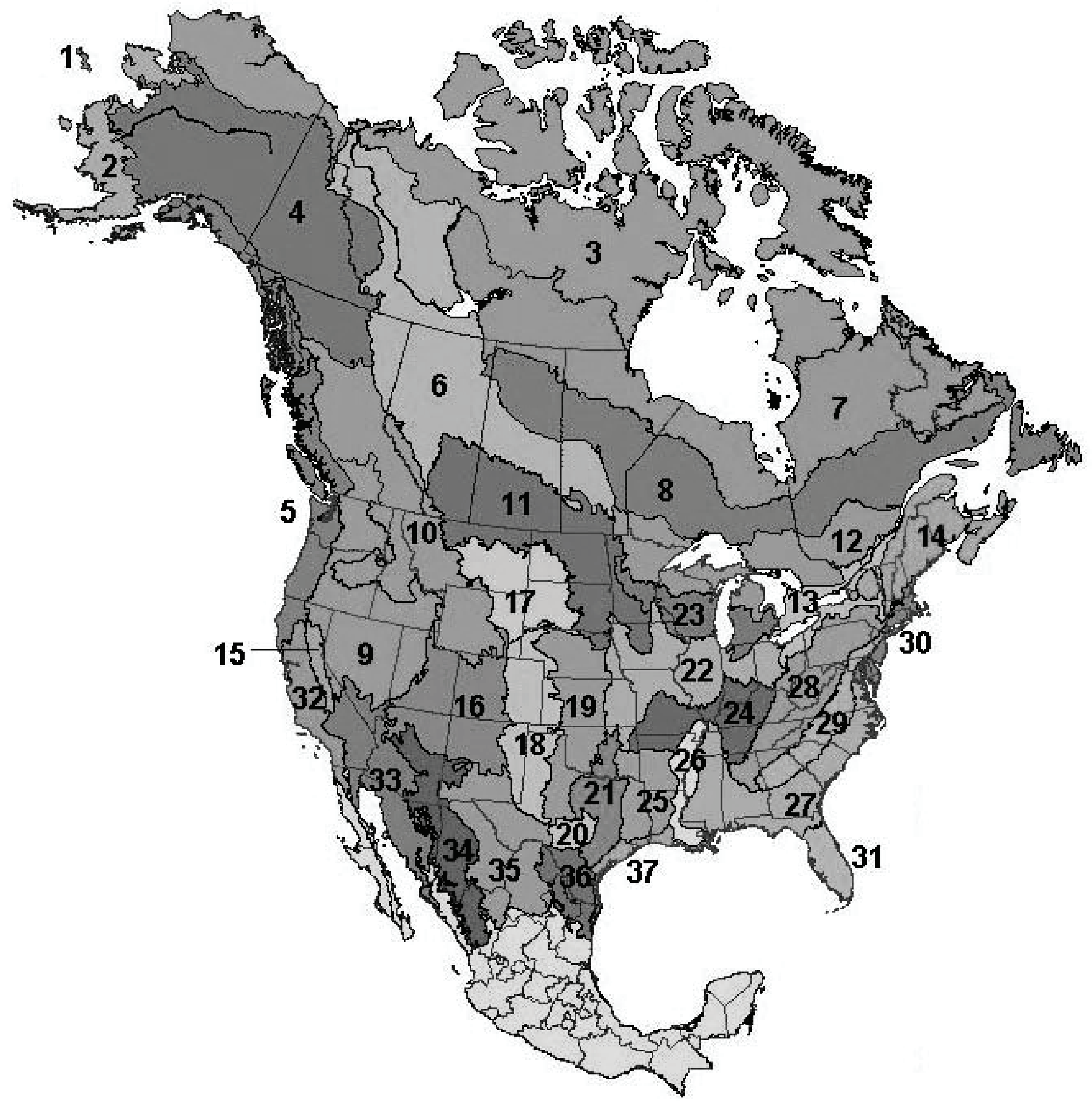

Figure 4-11. Bird Conservation Regions of the United States, Not Including Hawaii or U.S. Territories in the Pacific or Caribbean Oceans. (Notes: Herein, we only consider bird conservation regions 27, 31, and 37, and the avian species associated with these regions. This map was obtained from USDOI, FWS [2008, Figure 1, page 18]. For additional information regarding region descriptions, see North American Bird Conservation Initiative [2000]).

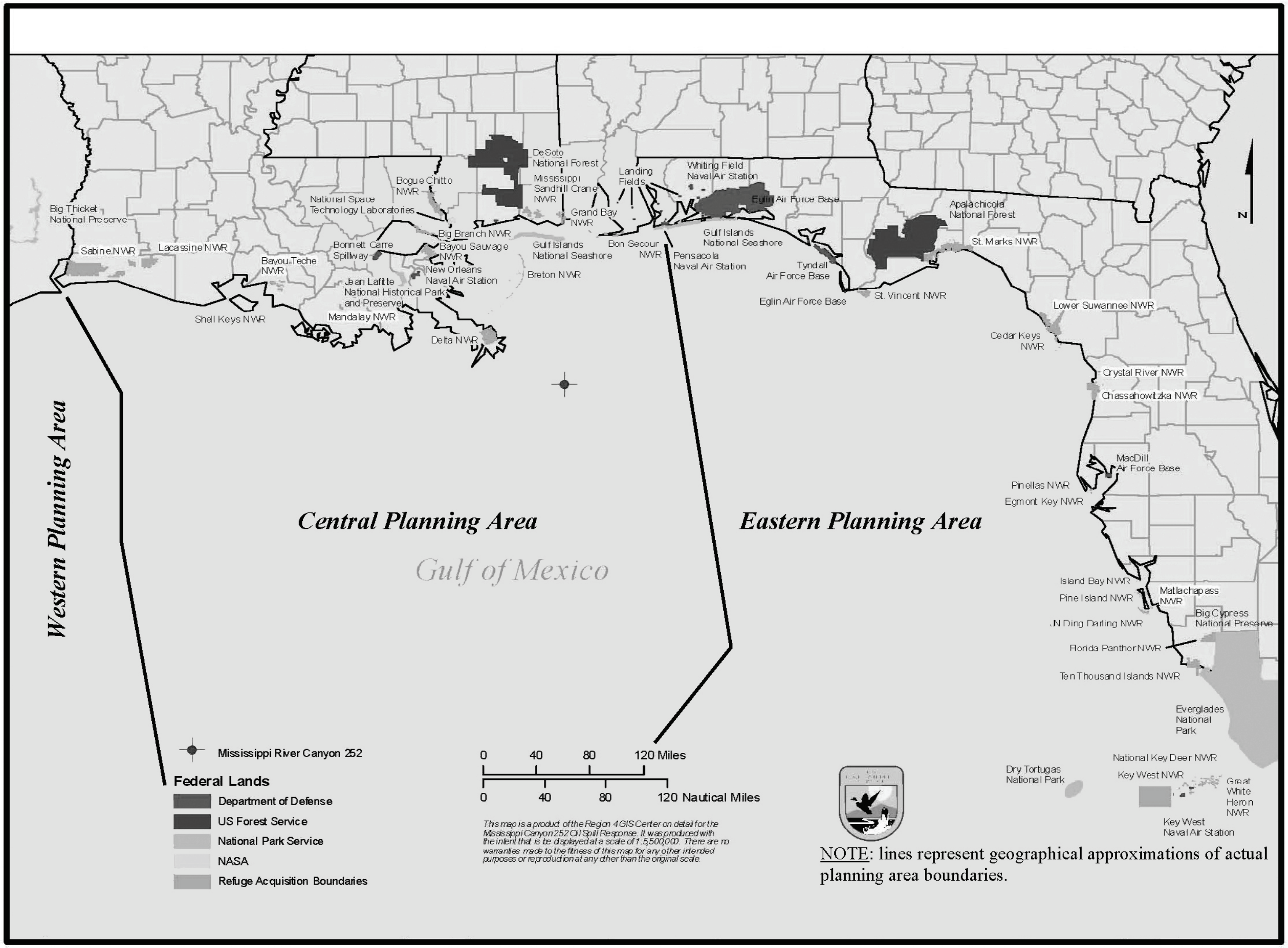

Figure 4-12. Map of the Coastal National Wildlife Refuges and Other Federal Lands in the Gulf of Mexico Region (USDOI, FWS, 2010a).

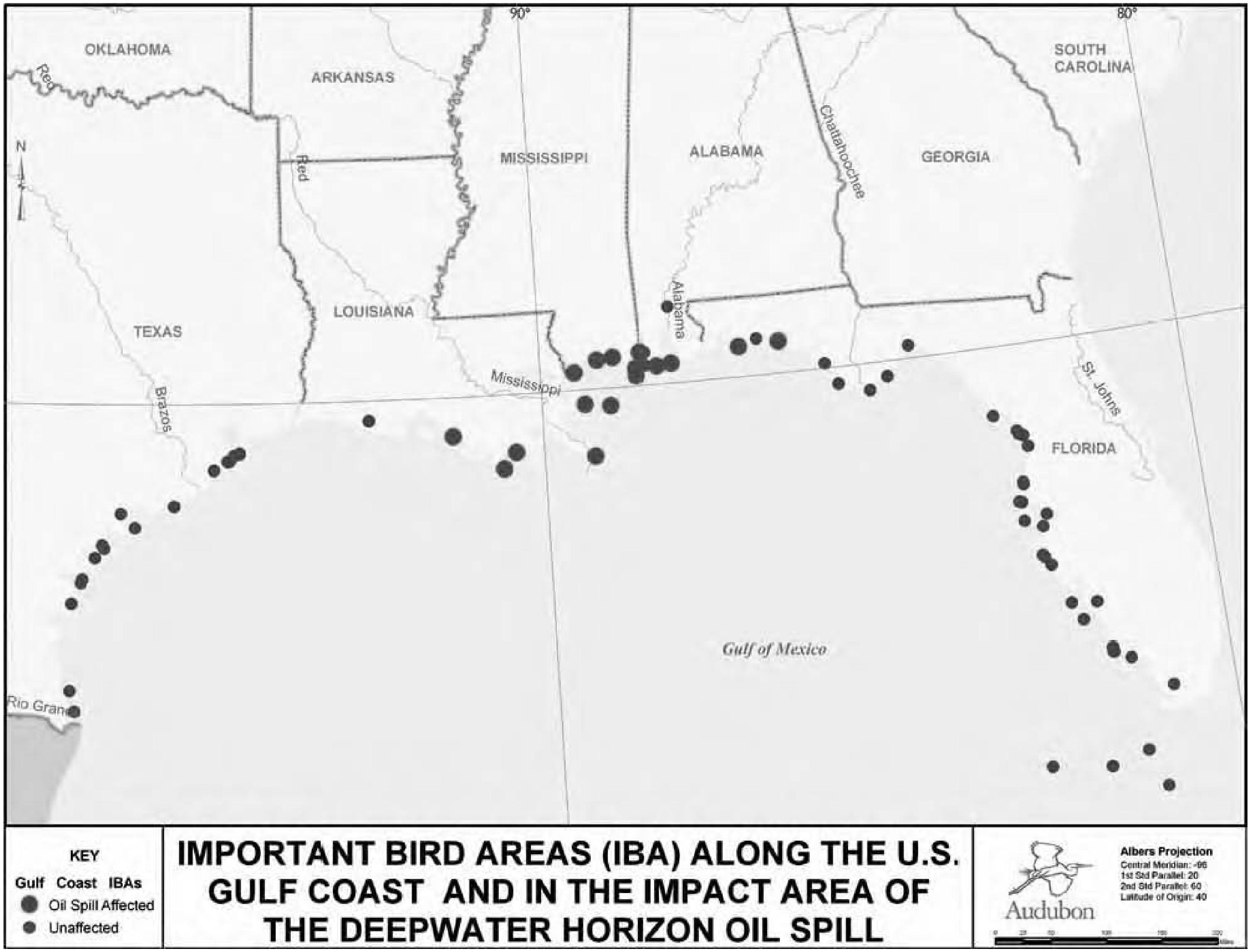

Figure 4-13. Important Bird Areas along the U.S. Gulf Coast and in the Impact Area of the *Deepwater Horizon* Oil Spill (reprinted with permission from the National Audubon Society, Inc., 2010).

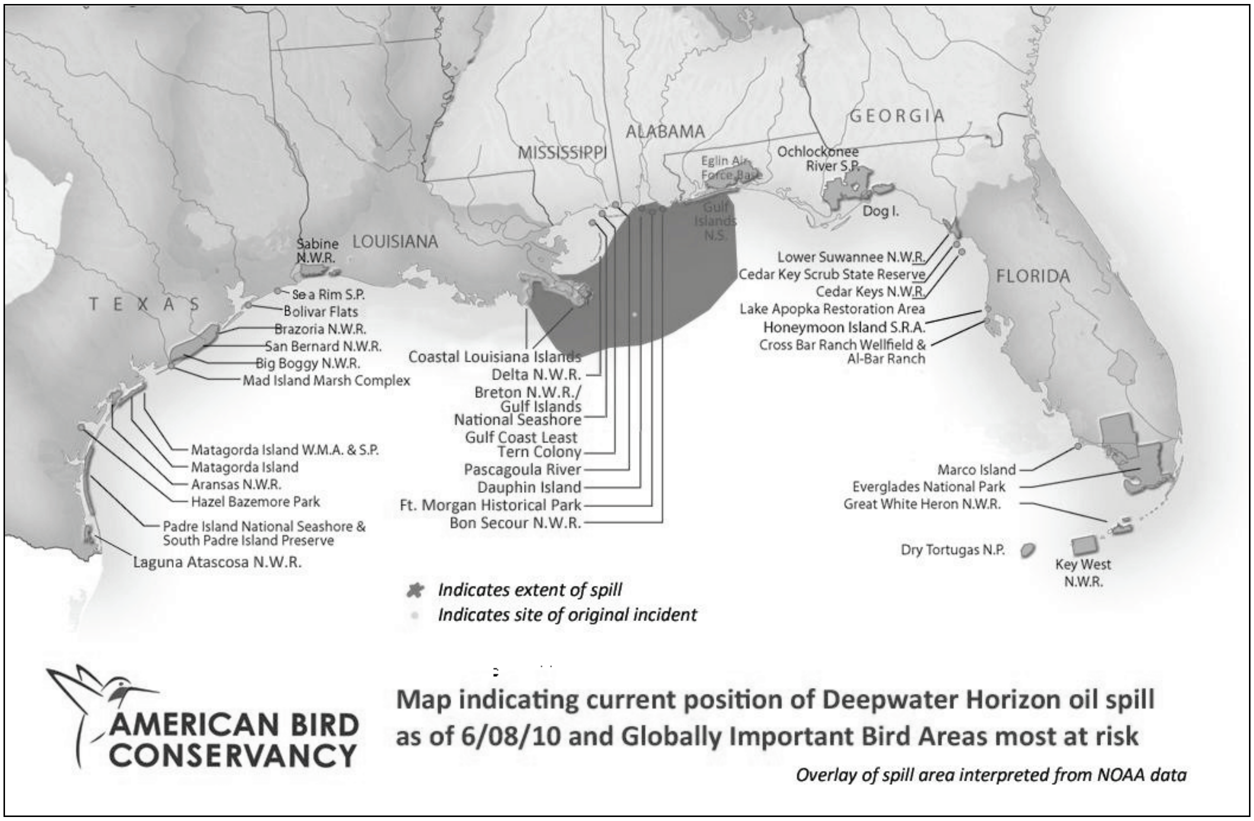

Figure 4-14. Map Indicating Position of the *Deepwater Horizon* Oil Spill as of June 2010 and Globally Important Bird Areas Most at Risk (reprinted with permission from the American Bird Conservancy, 2010).

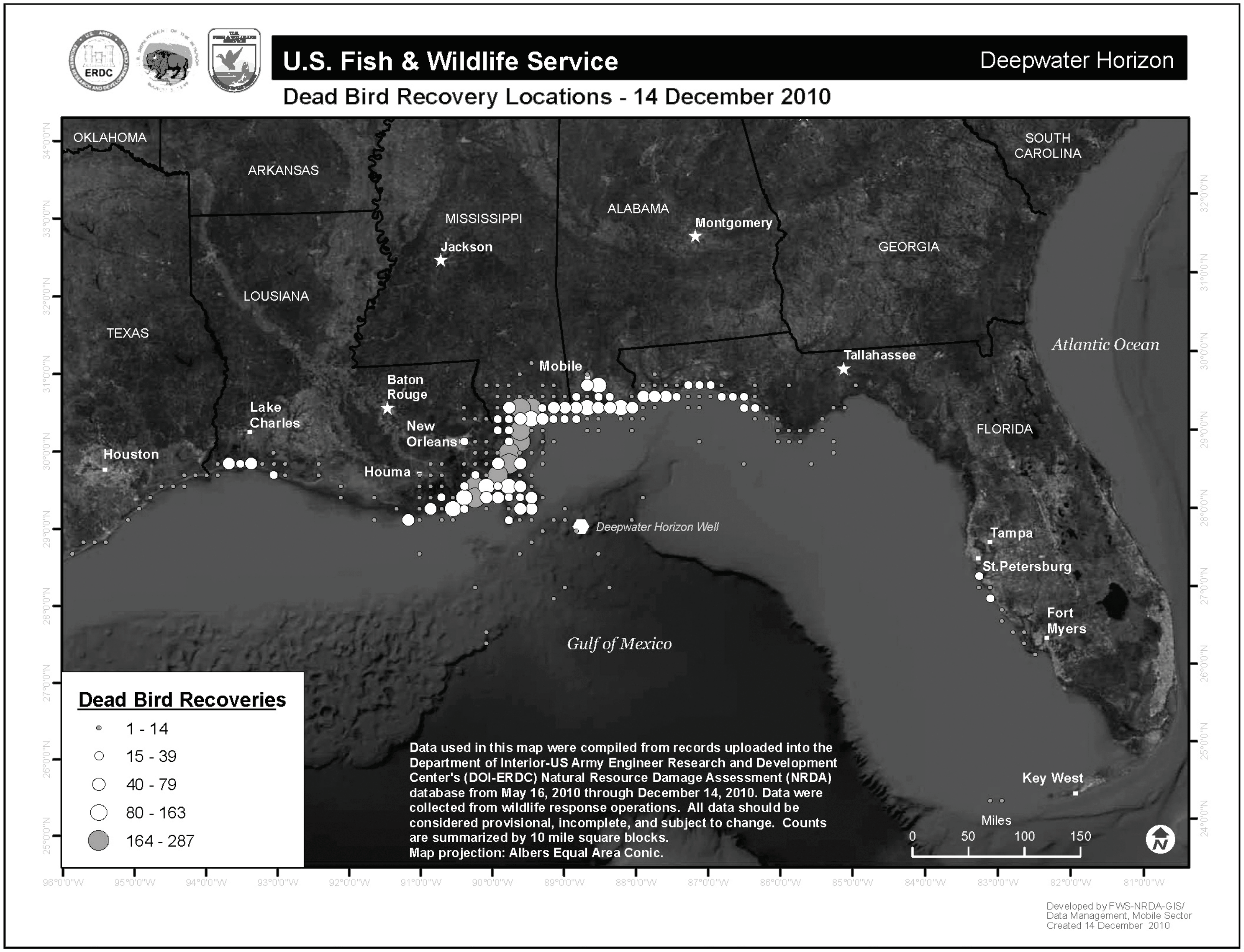

Figure 4-15. Dead Bird Recovery Locations (December 14, 2010) (USDOI, FWS, 2010b).

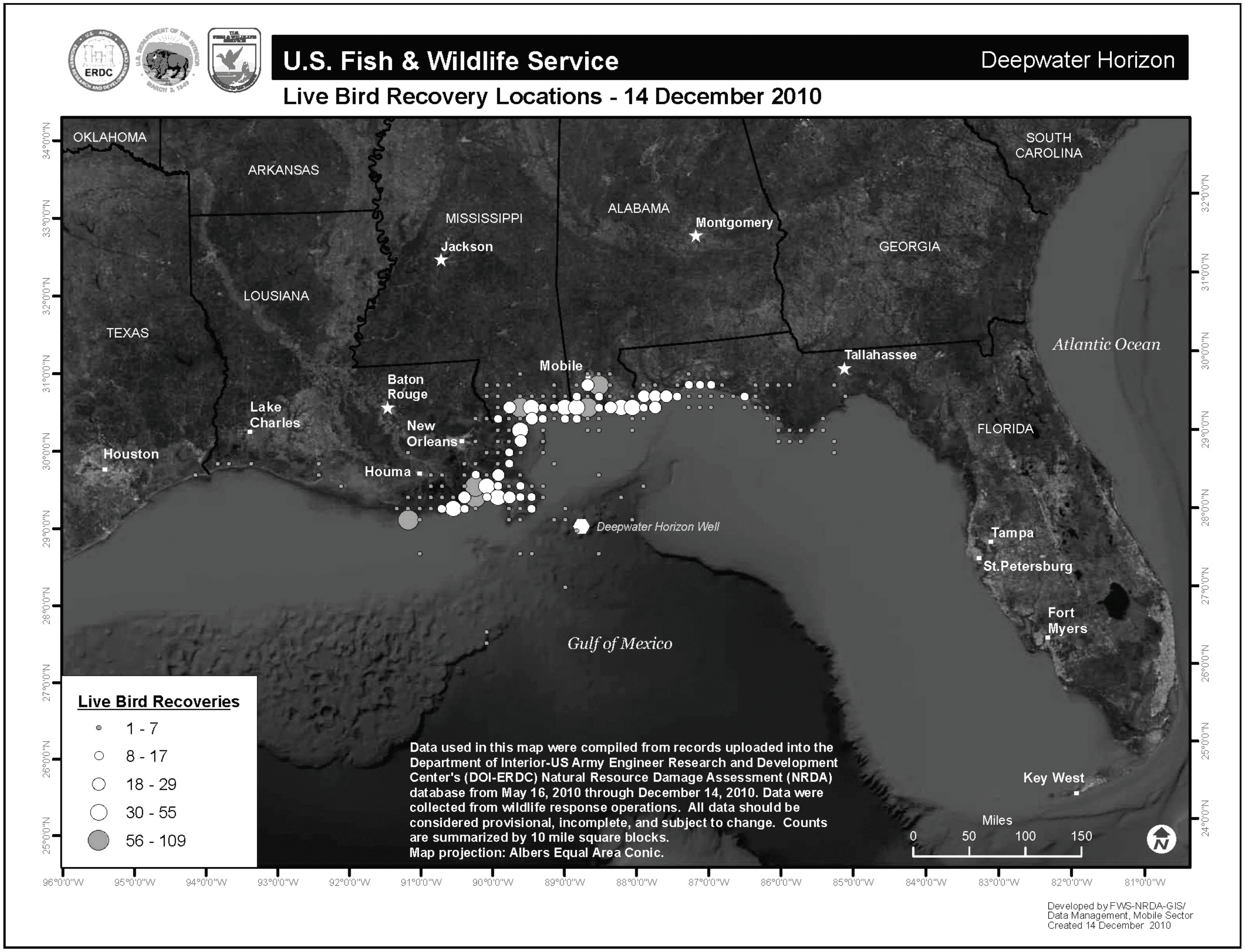

Figure 4-16. Live Bird Recovery Locations (December 14, 2010) (USDOI, FWS, 2010c).

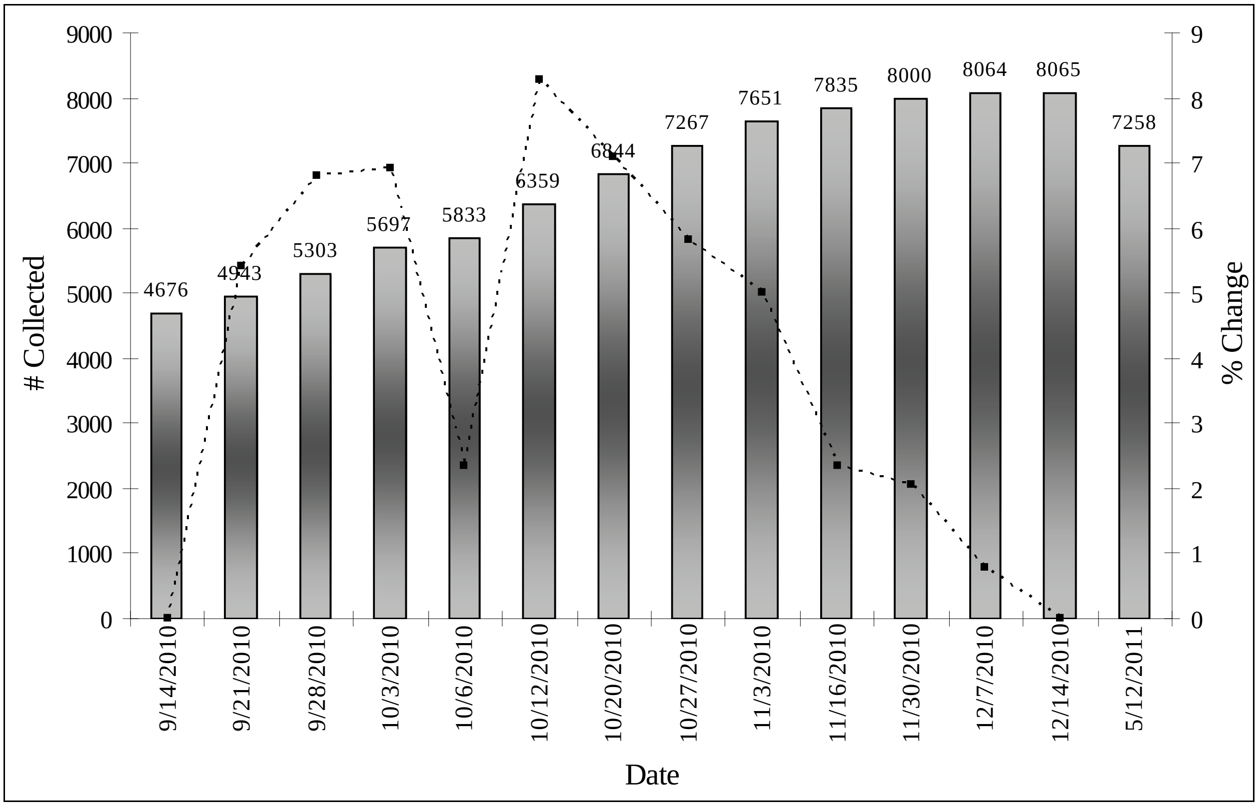

Figure 4-17. Summary of Avian Species Collected by Date Obtained from the Fish and Wildlife Service (USDOI, FWS, 2011) as Part of the *Deepwater Horizon* Post-Spill Monitoring and Collection Process through May 12, 2011. Data on the Y-axis reflect the cumulative # of individual birds collected, identified, and summarized by date, and data on the Z-axis reflect proportional change from one reporting date to the next. The data used in this table are verified as per the FWS QA/QC processes. Disclaimer: All data should be considered provisional, incomplete, and subject to change. For more information see the following link to the FWS Weekly Bird Impact Data and Consolidated Wildlife Reports at http://www.fws.gov/home/dhoilspill/pdfs/Bird%20Data%20Species%20Spreadsheet%20 05122011.pdf. Mean # of birds collected between intervals is 184.4 $\pm$ 89.3 SE (-807 min, 526 max for 13 collection intervals) and the mean % change between intervals is 3.0 $\pm$ 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.

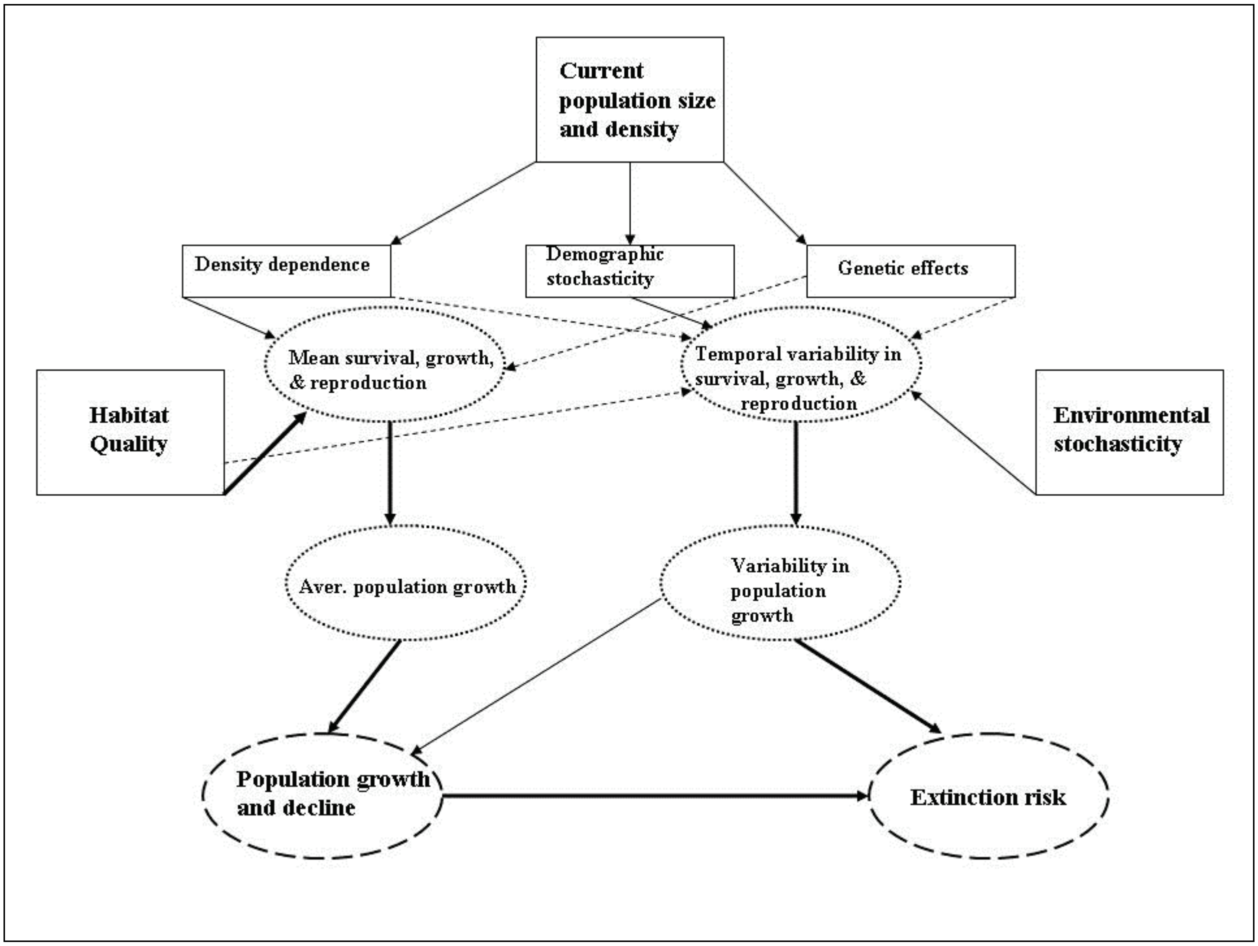

Figure 4-18. Diagram of Various Factors Influencing Population Viability for a Hypothetical Avian Species Breeding and/or Wintering in the Gulf of Mexico. (Notes: The structure of boxes, rectangles, ovals, and oval outlines indicates the variability in a given factors potential to influence population growth and extinction risk, whereas the width and structure of the arrows indicates the strength of an effect associated with a factor. An oil spill would most likely enter the hypothetical population at the left side of the diagram, initially influencing habitat quality [direct] and potentially mean survival [direct via mortality] with latent [indirect] effects to growth [primarily to offspring] and future reproduction (both adults and offspring). Effects would cascade through the diagram eventually influencing population growth rate and extinction risk or probability. Adapted from Morris and Doak [2002, Figure 2.1]. The diagram is provided for discussion purposes only and is not necessarily representative of a specific avian species known to occur in the Gulf of Mexico.)

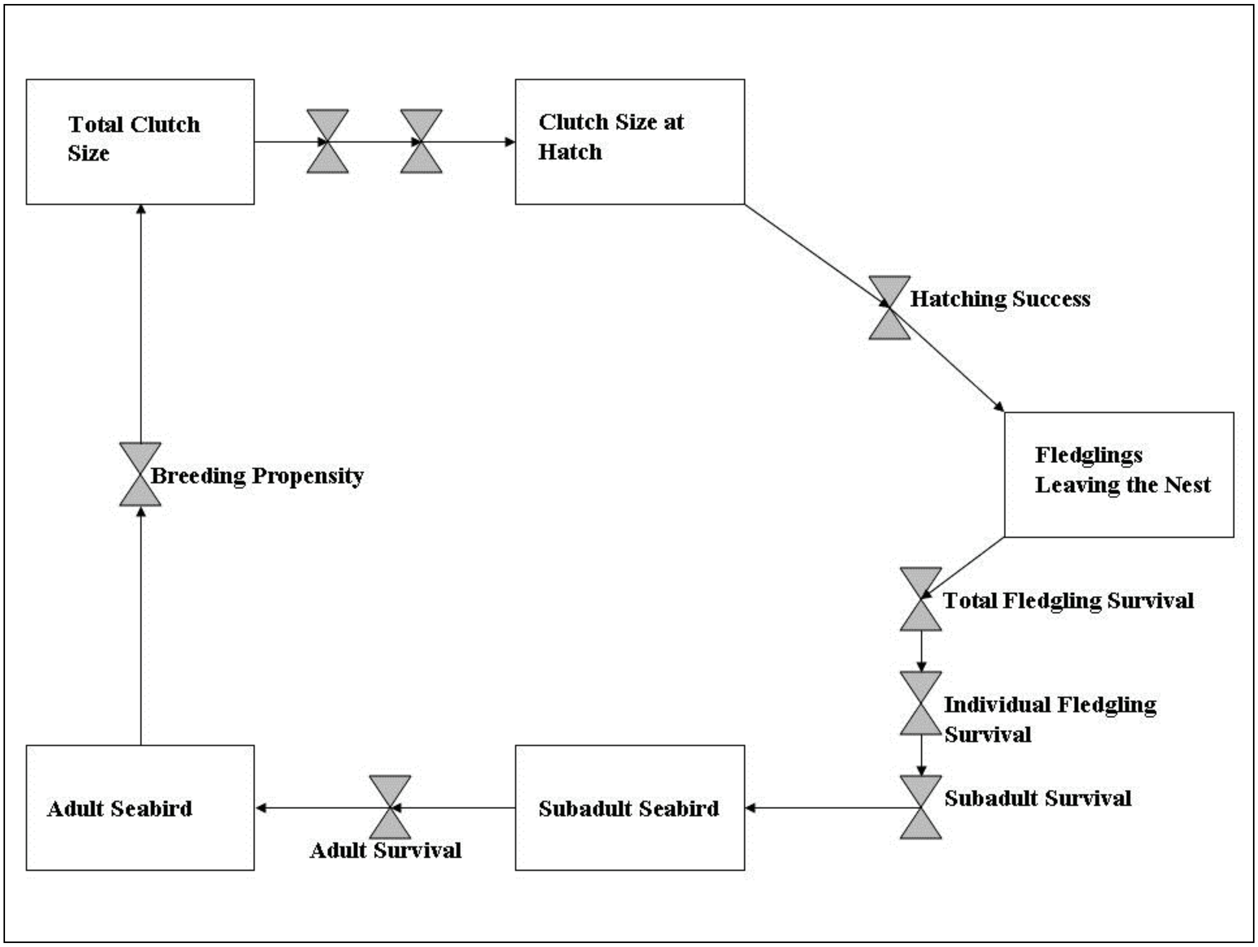

Figure 4-19. Life Cycle Model of the Fitness Components Associated with a Hypothetical Breeding Seabird Species Showing Reproductive Output from a Single Nest. (Notes: State variables are indicated as boxes and transition variables as bowties. Adapted from Cooke et al. [1995, Figure 4.1]. The model is provided for discussion purposes only and is not necessarily representative of a specific seabird species known to occur in the Gulf of Mexico.)

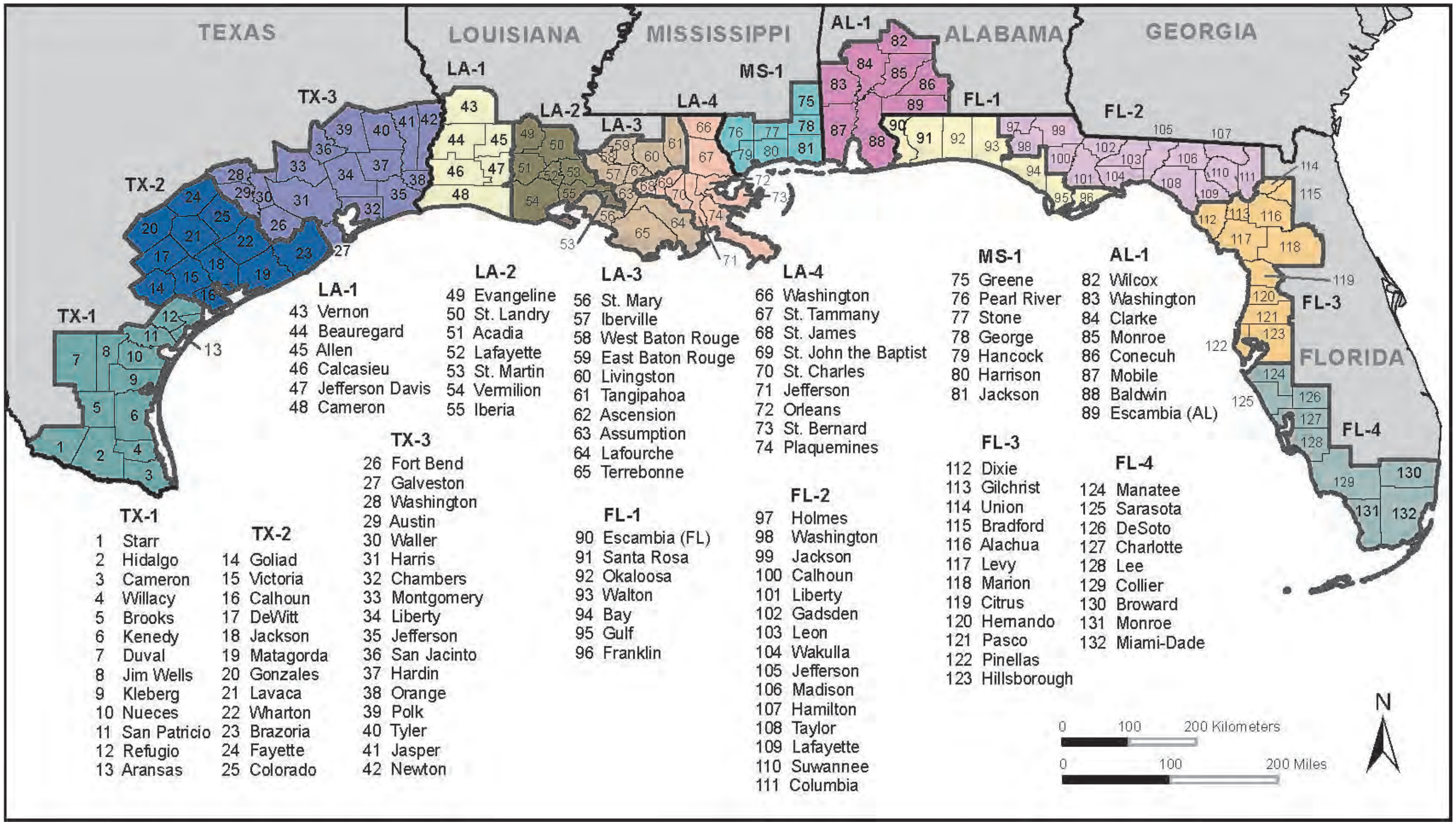

Figure 4-20. Economic Impact Areas in the Gulf of Mexico.

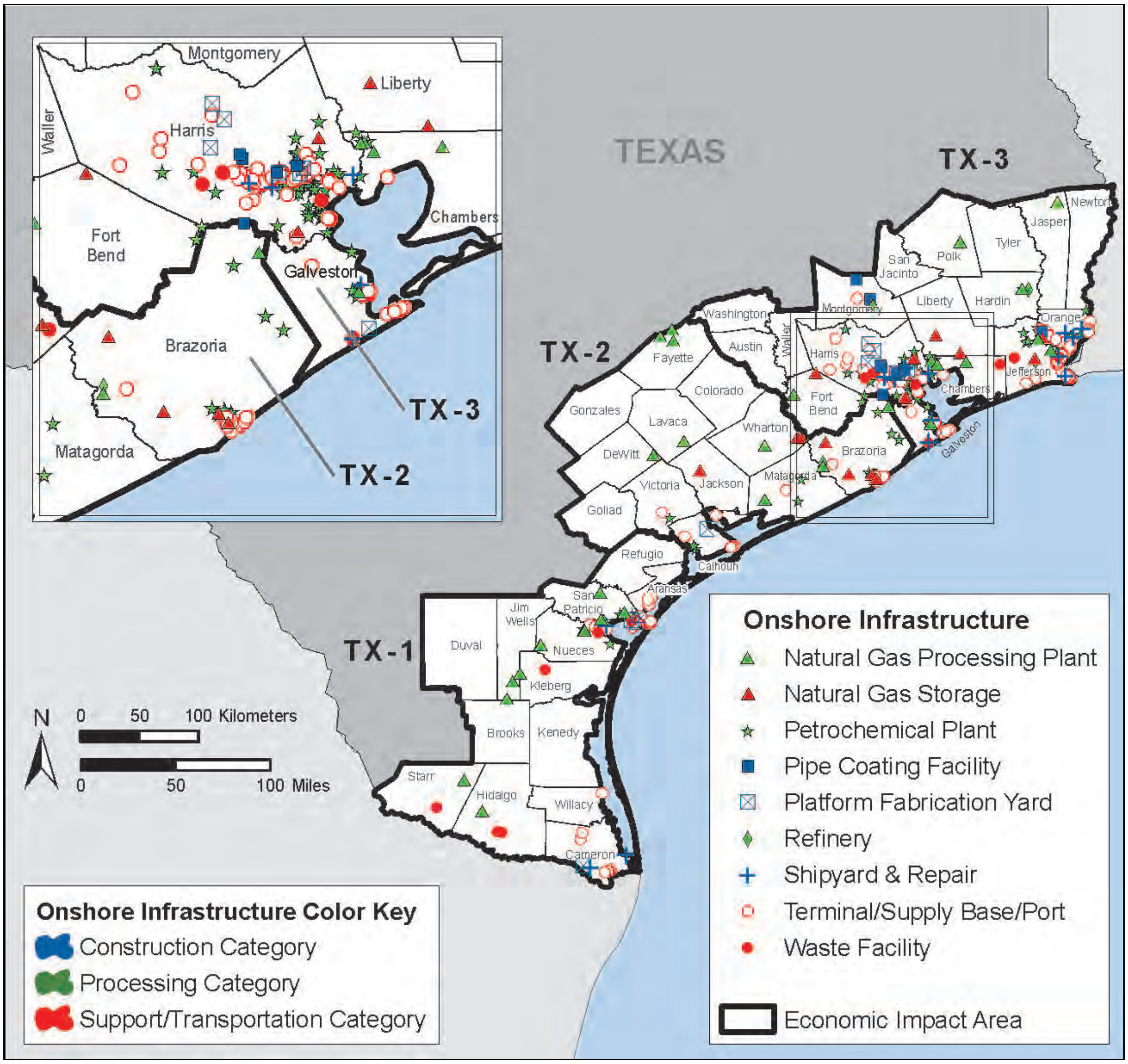

Figure 4-21. Onshore Infrastructure Located in Texas (Dismukes, 2011).

Figure 4-22. Onshore Infrastructure Located in Louisiana and Mississippi (Dismukes, 2011).

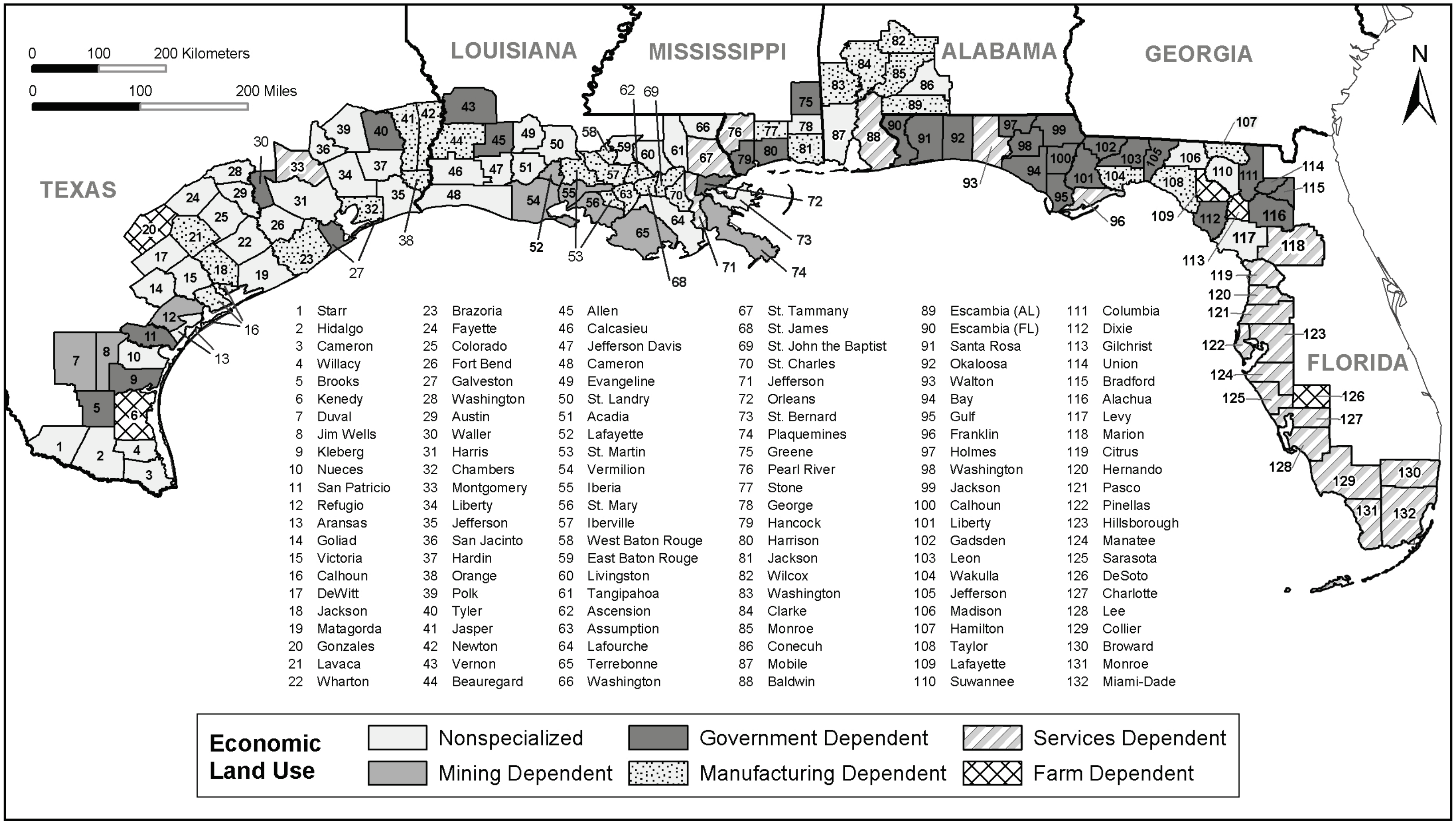

Figure 4-23. Economic Land-Use Patterns (U.S. Dept. of Agriculture, Economic Research Service, 2004).

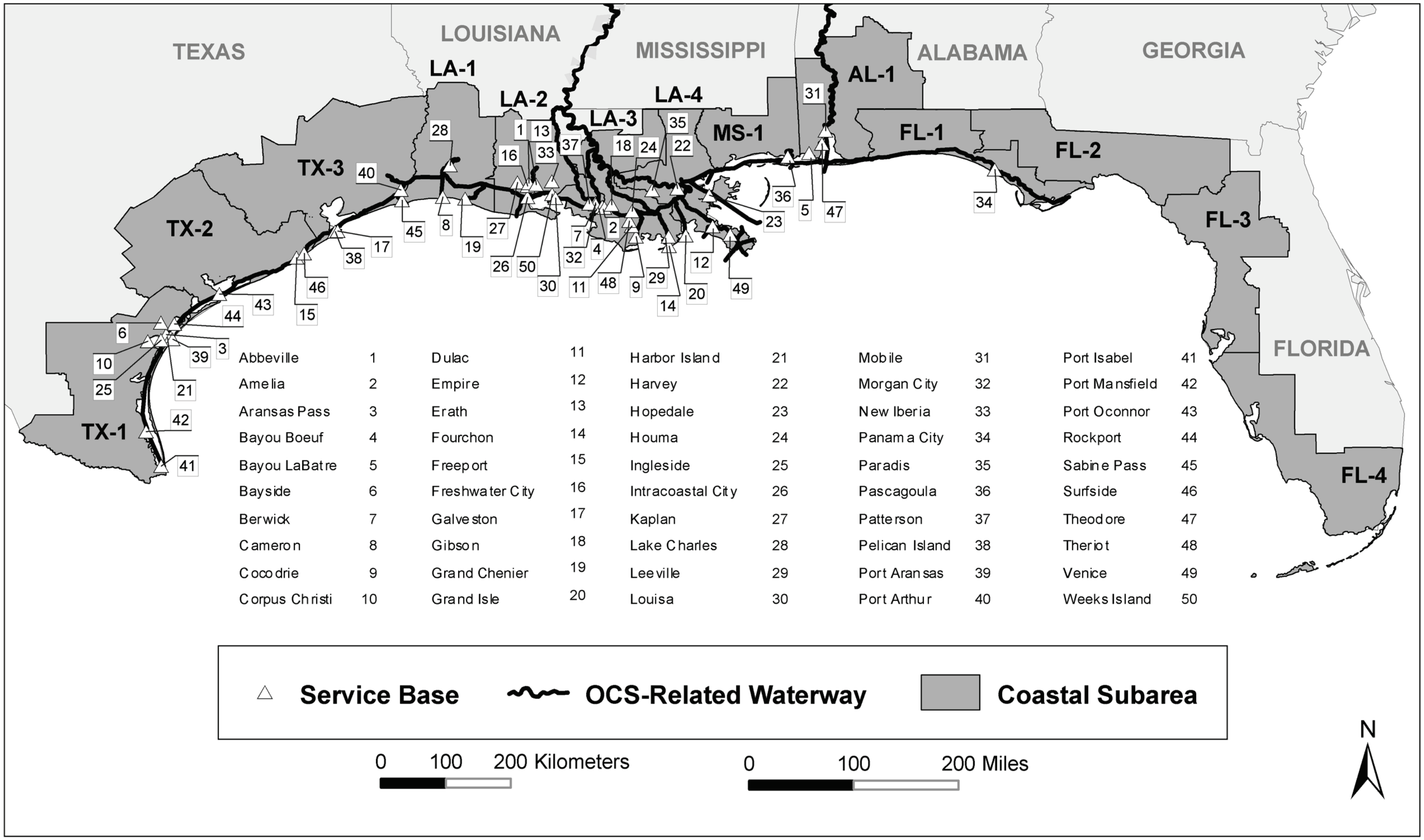

Figure 4-24. OCS-Related Service Bases in the Gulf of Mexico (Dismukes, 2011).

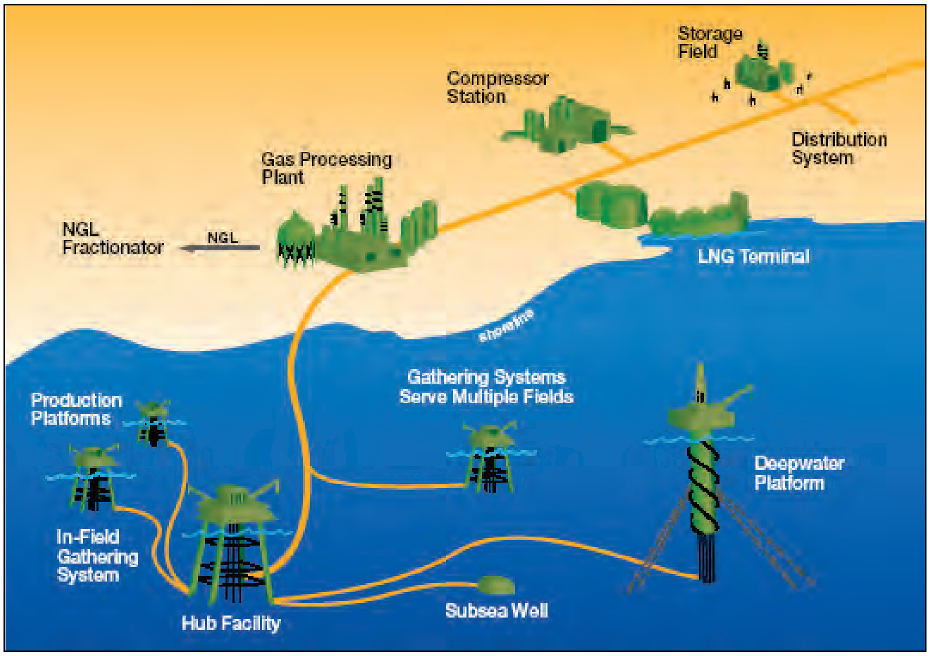

Figure 4-25. Gas Supply Schematic for the Gulf of Mexico (Dismukes, 2010).

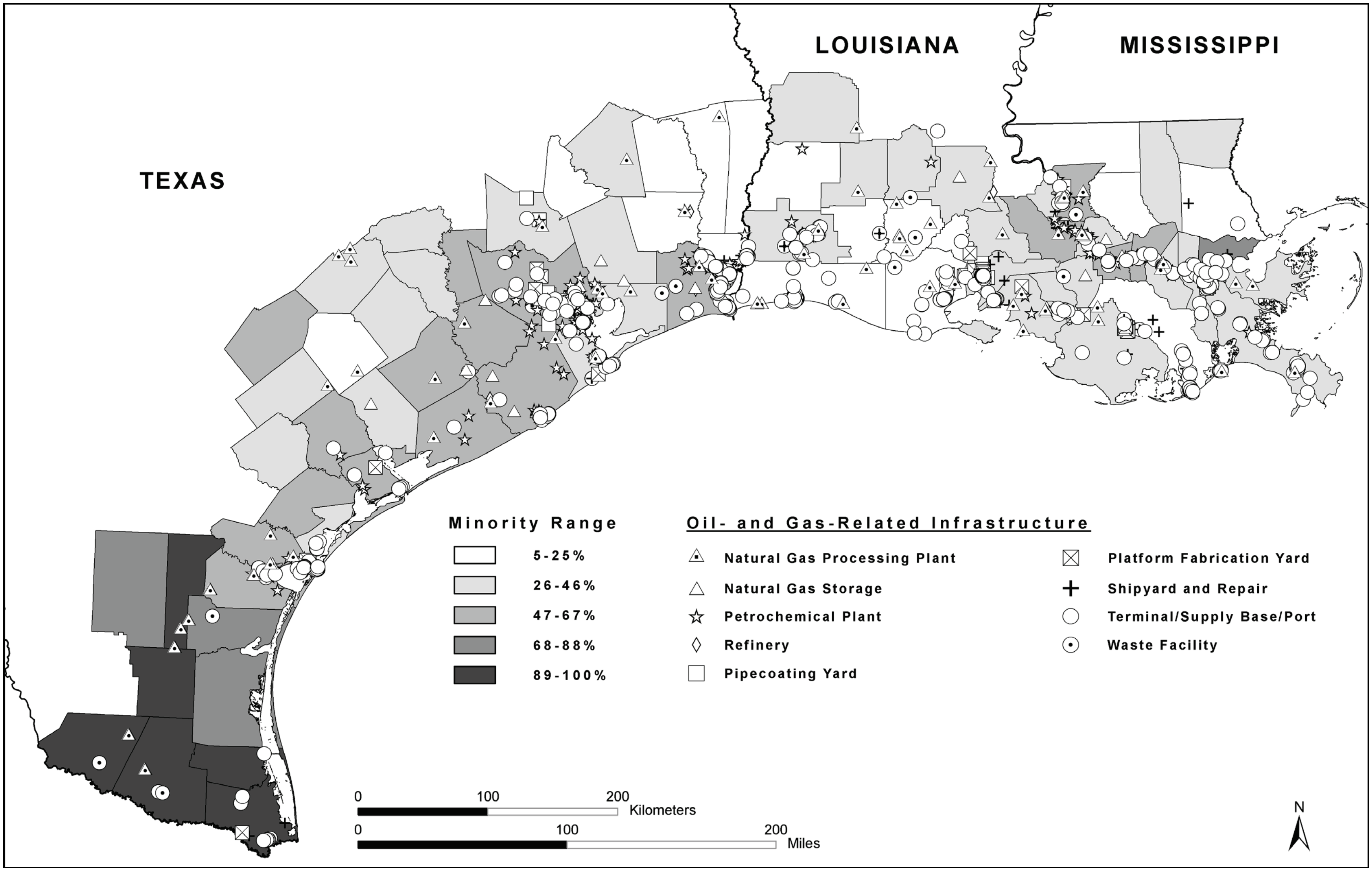

Figure 4-26. Percentage of Minority Population by County in Texas and by Parish in Louisiana with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

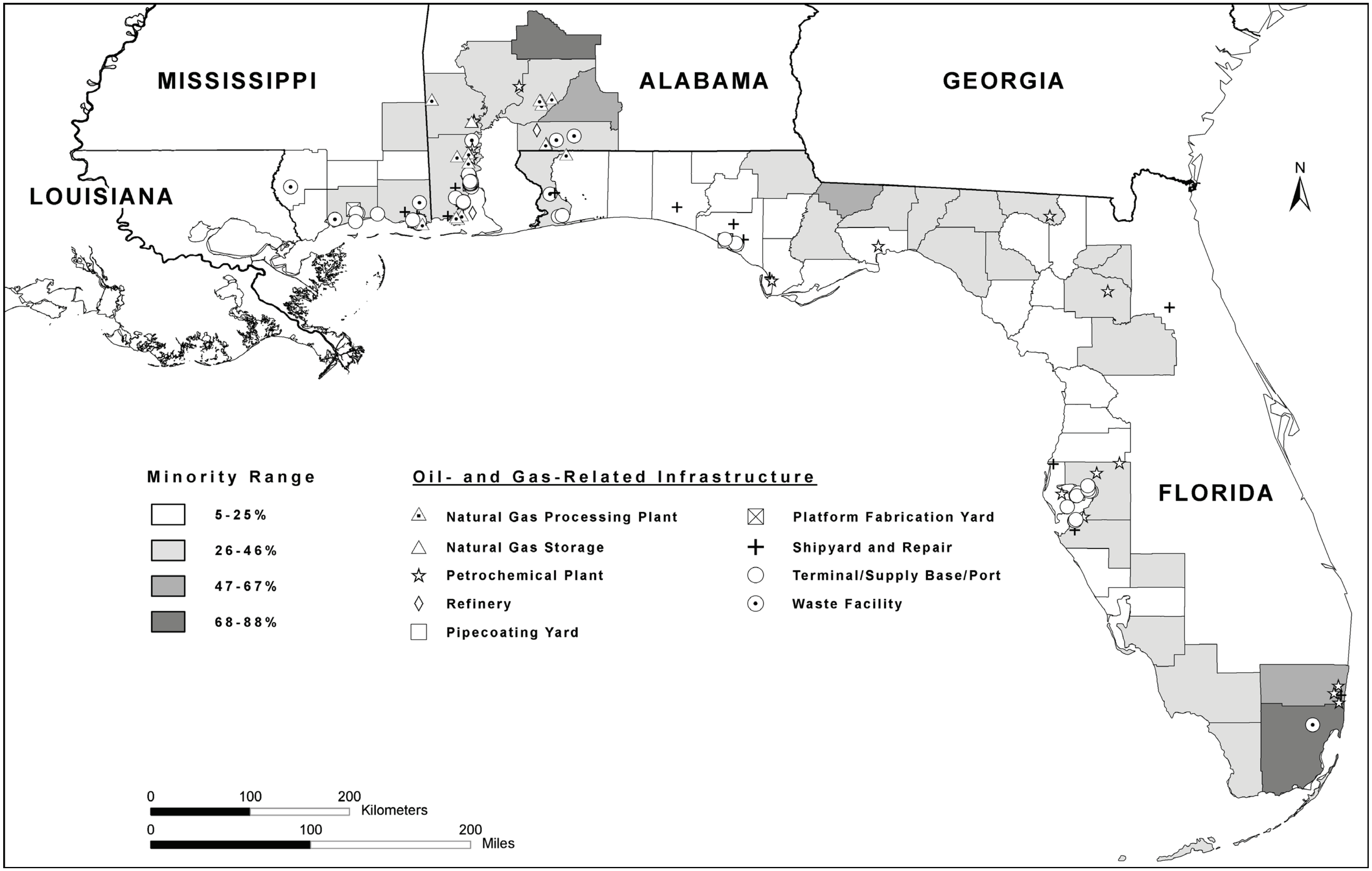

Figure 4-27. Percentage of Minority Population by County in Mississippi, Alabama, and Florida with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

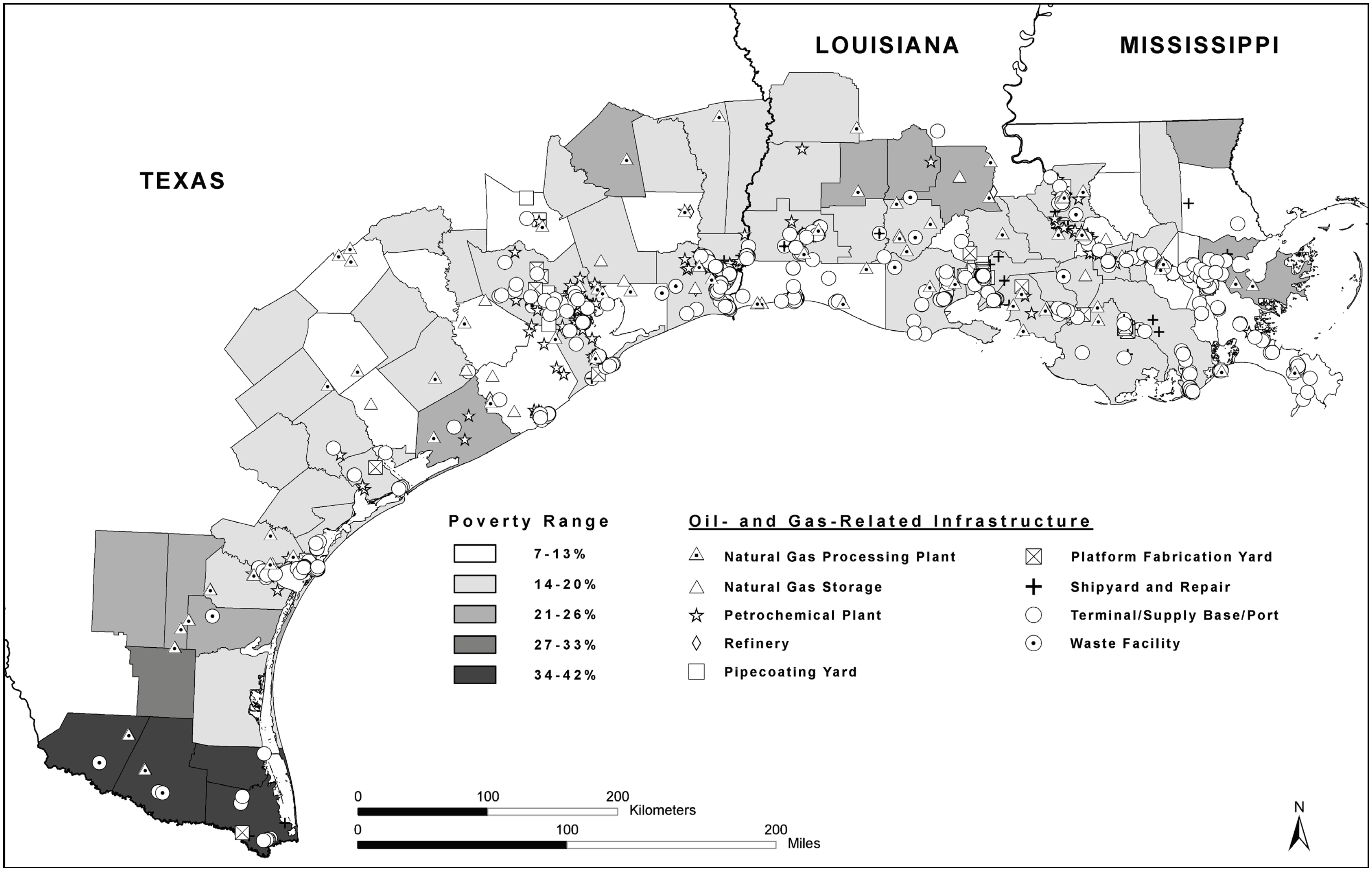

Figure 4-28. Percentage of Poverty by County in Texas and by Parish in Louisiana with Distribution of OCS Infrastructure (Sources: Poverty Range, USDOC, Census Bureau, 2009; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

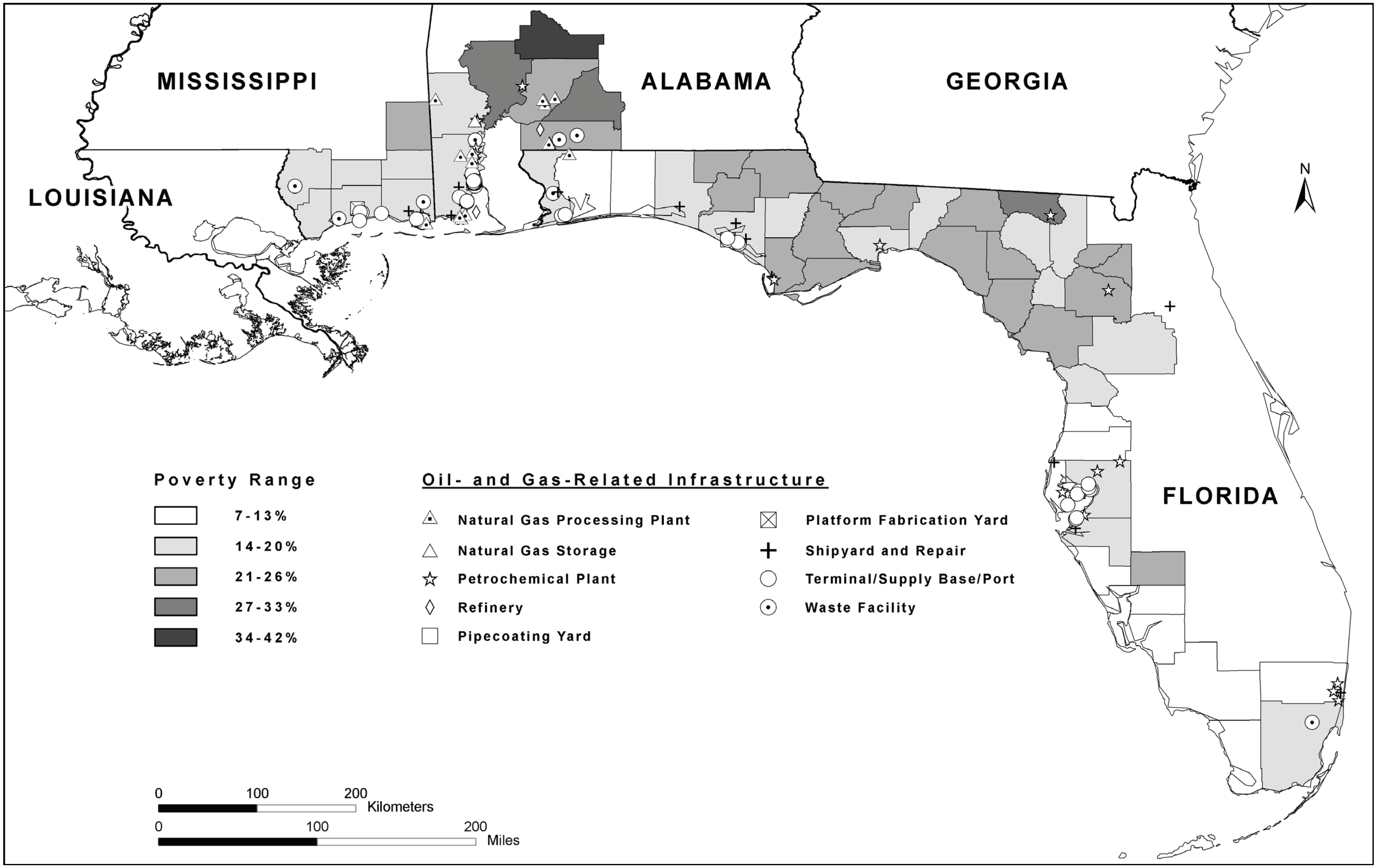

Figure 4-29. Percentage of Poverty by County in Mississippi, Alabama, and Florida with Distribution of OCS Infrastructure (Sources: Poverty Range, USDOC, Census Bureau, 2009; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

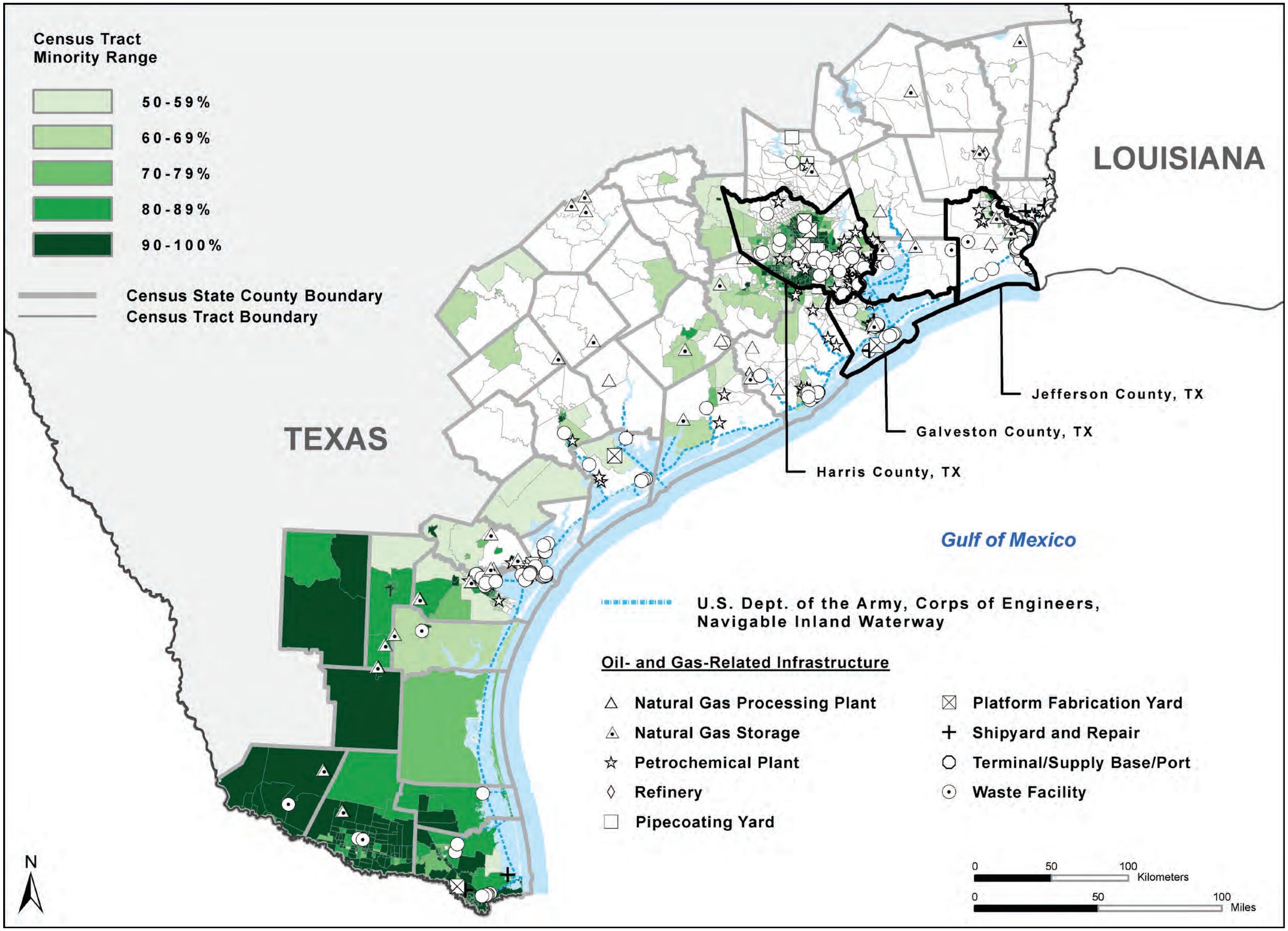

Figure 4-30. Percentage of Minority Population by Census Tract in Texas with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

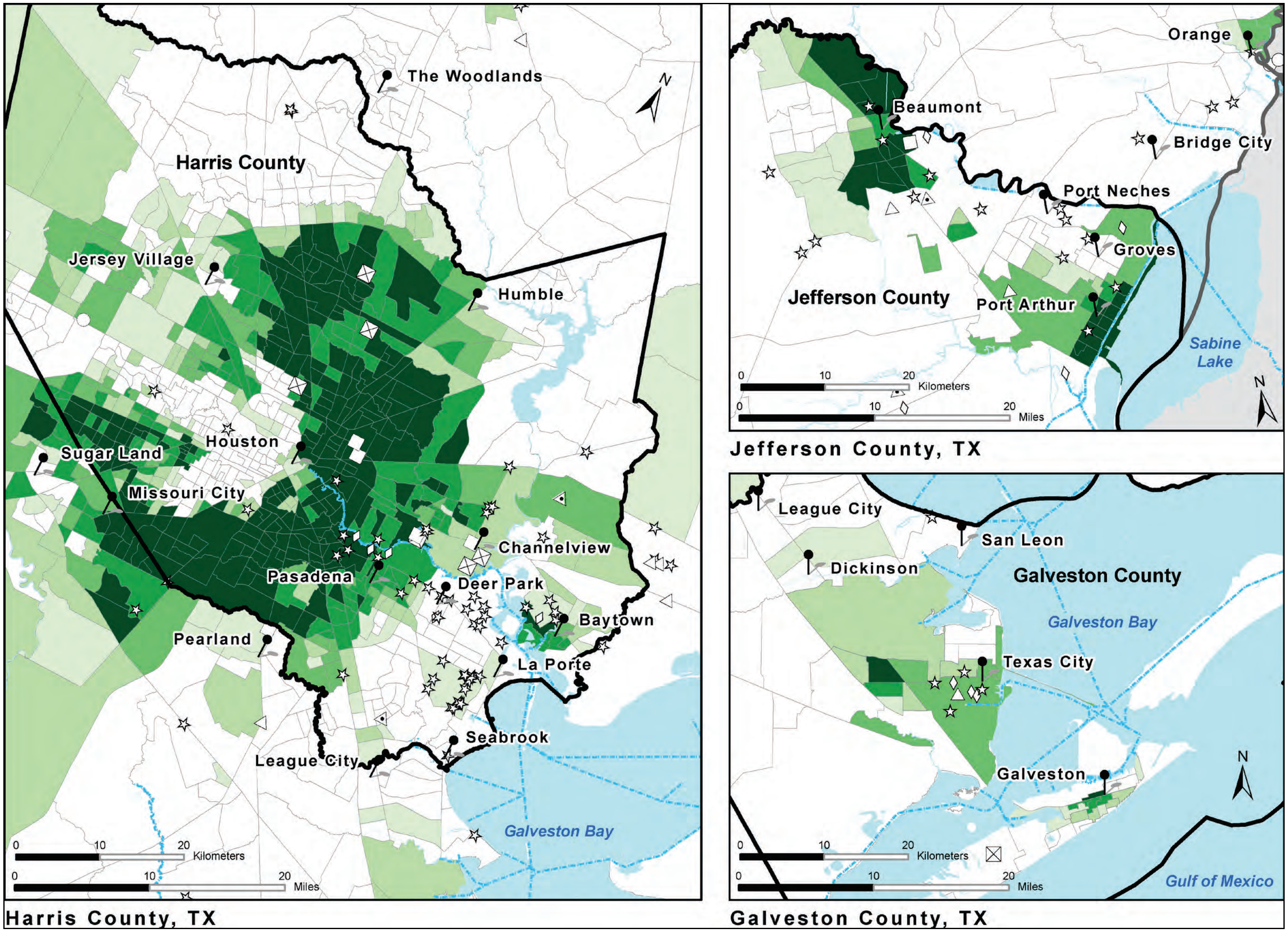

Figure 4-31. Percentage of Minority Population by Census Tract in Harris, Jefferson, and Galveston Counties in Texas with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

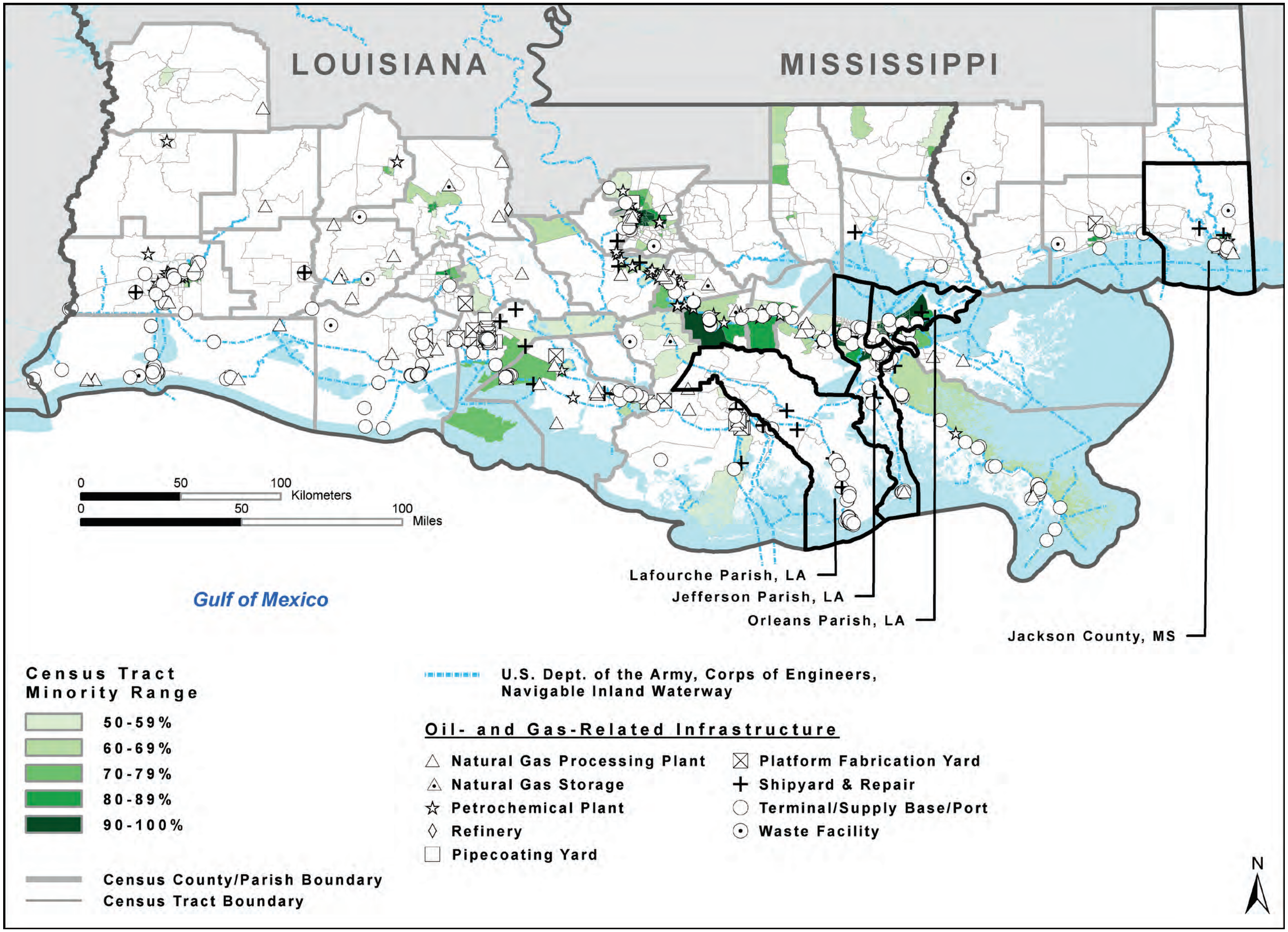

Figure 4-32. Percentage of Minority Population by Census Tract in Louisiana with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

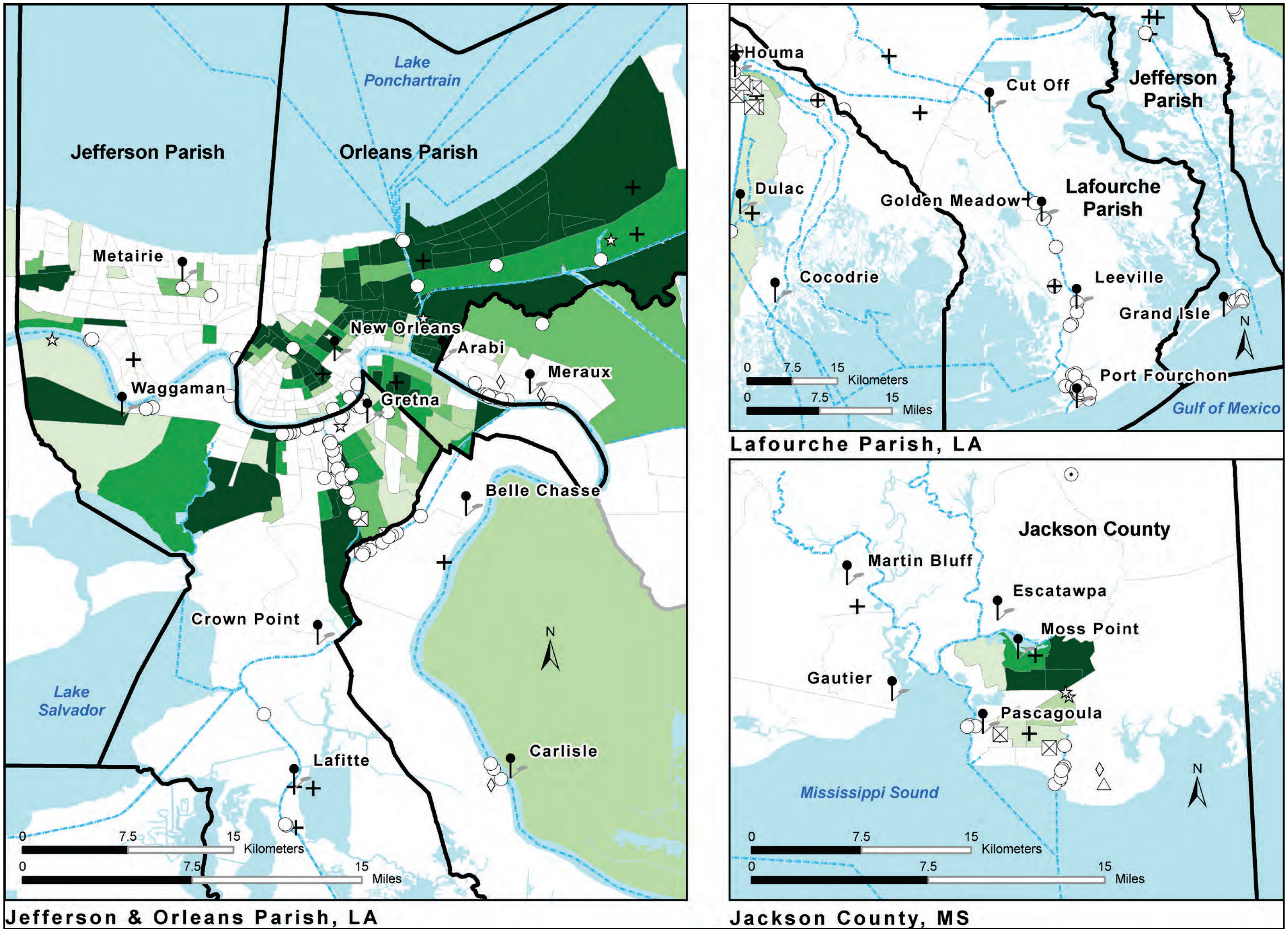

Figure 4-33. Percentage of Minority Population by Census Tract in Jefferson, Orleans, and Lafourche Parishes in Louisiana and in Jackson County in Mississippi with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

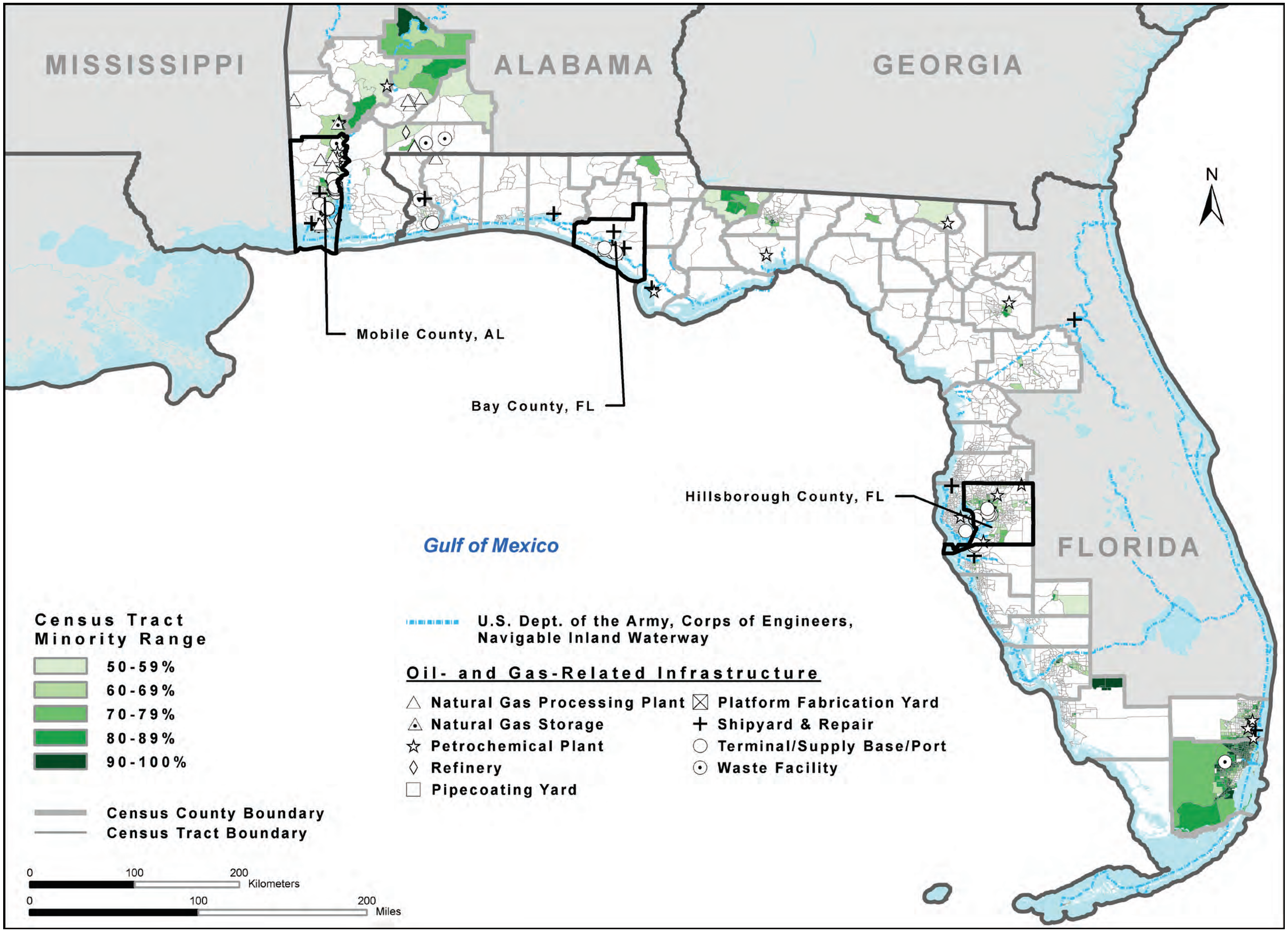

Figure 4-34. Percentage of Minority Population by Census Tract in Alabama and Florida with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

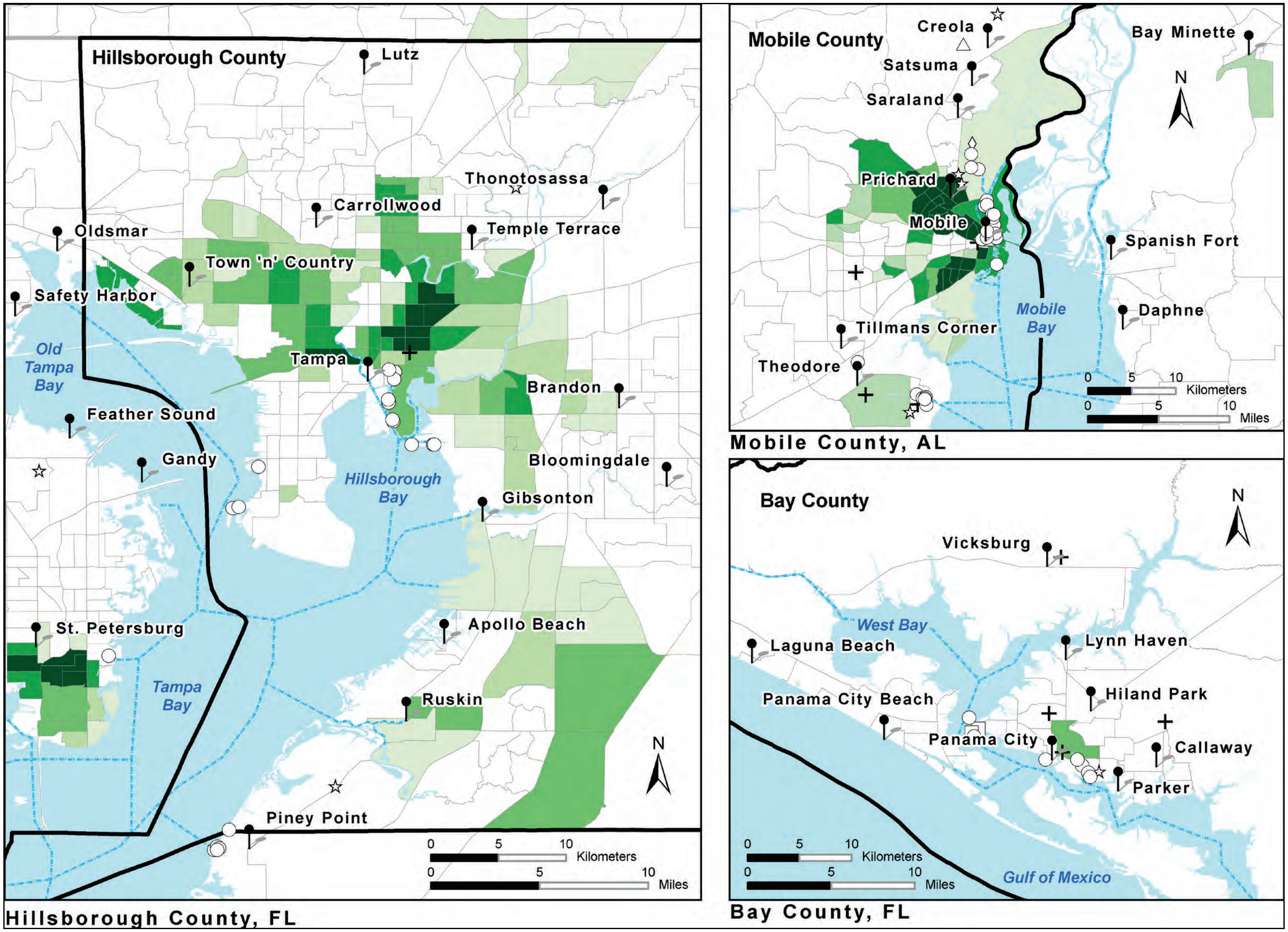

Figure 4-35. Percentage of Minority Population by Census Tract in Hillsborough and Bay Counties in Florida and in Mobile County in Alabama with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Dismukes, 2011).

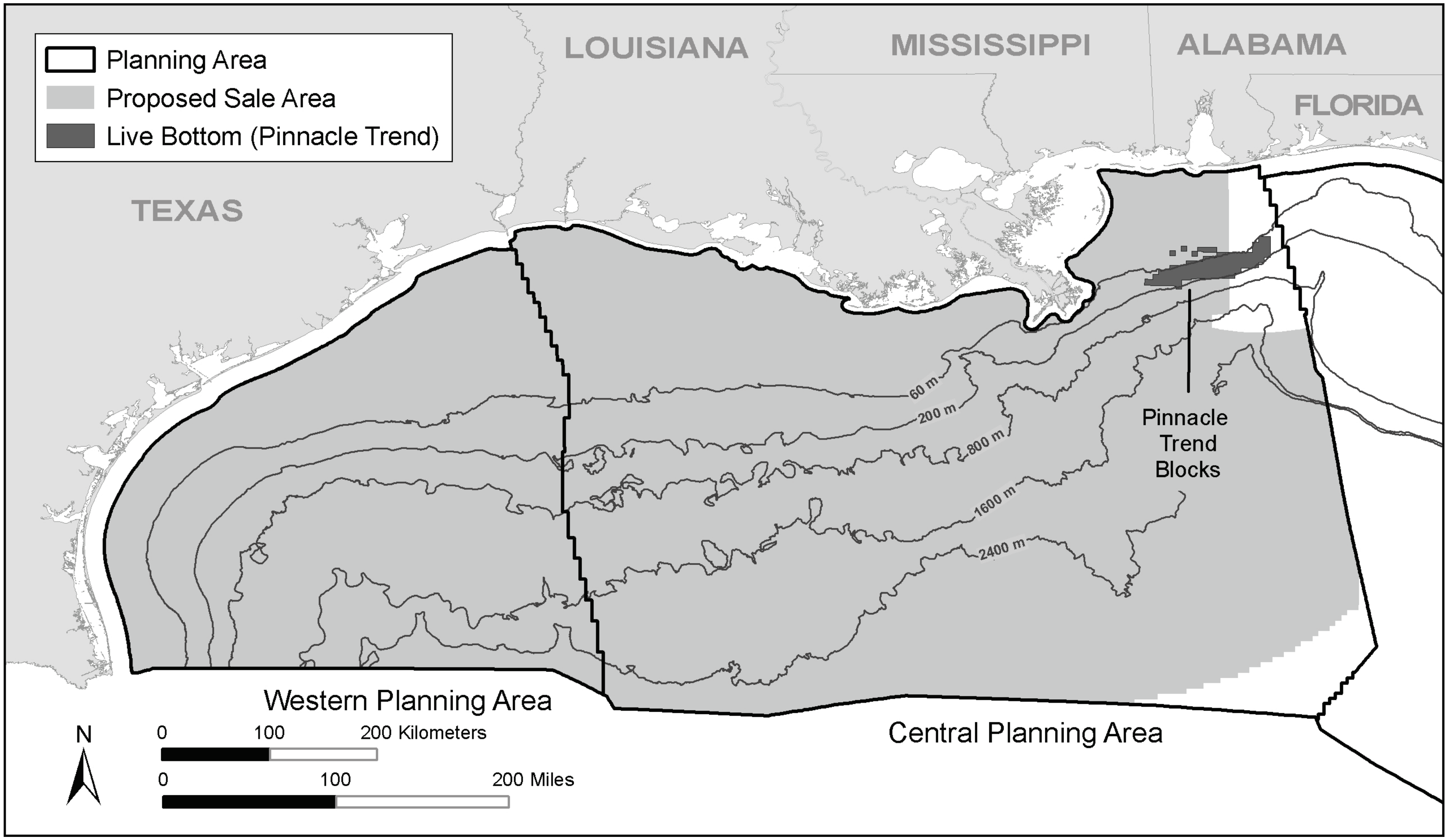

Figure 4-36. Location of Pinnacle Trend Blocks in the Central Planning Area.

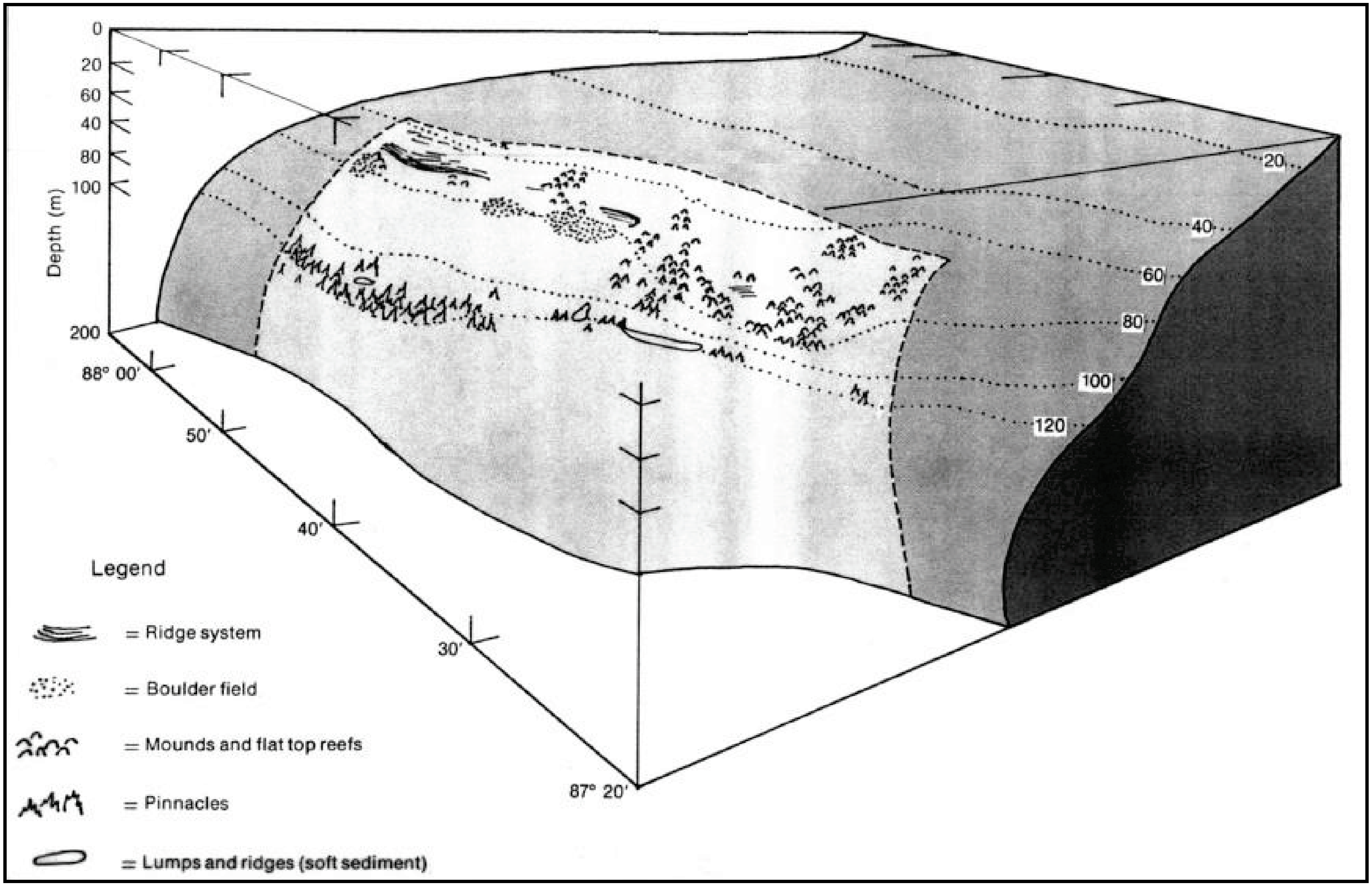

Figure 4-37. Perspective View of the Central Sector of the Mississippi-Alabama Continental Shelf Showing the General Distribution of Different Types of Topographic Features in the Depth Range of 60-120 m (197-394 ft) (light shading indicates the area surveyed for topographic features) (Brooks and Giammona, 1991).

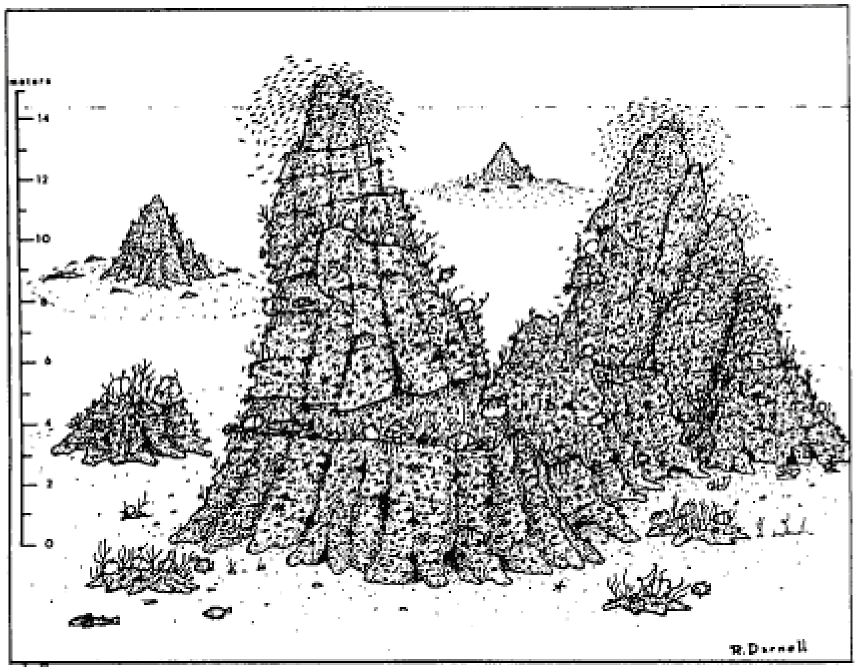

Figure 4-38. Perspective Sketch of the Submerged Landscape of a Pinnacle Province as Visualized from Side-Scan Sonar and Remotely Operated Vehicle Information (Brooks and Giammona, 1990).

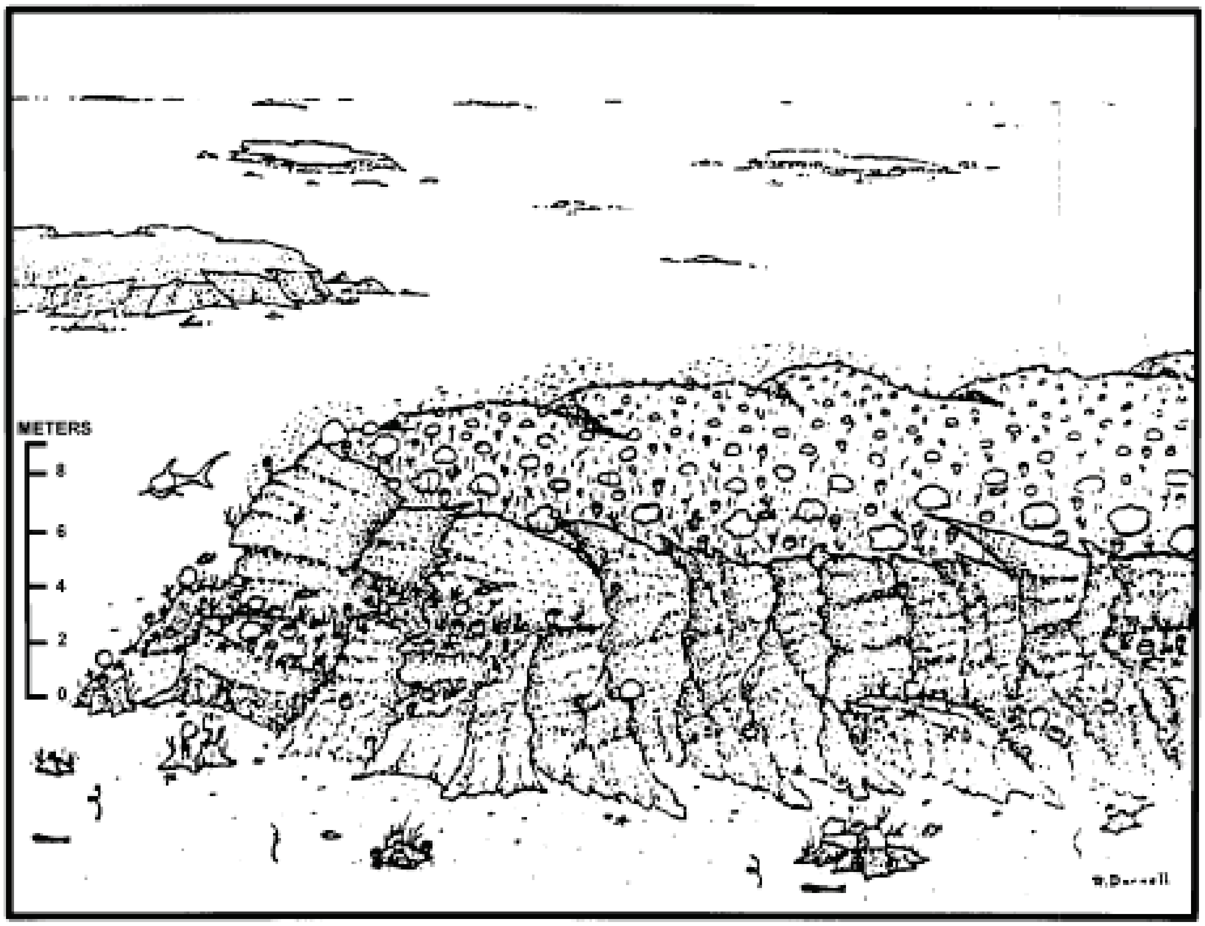

Figure 4-39. Sketch of a Submerged Ridge (Brooks and Giammona, 1990).

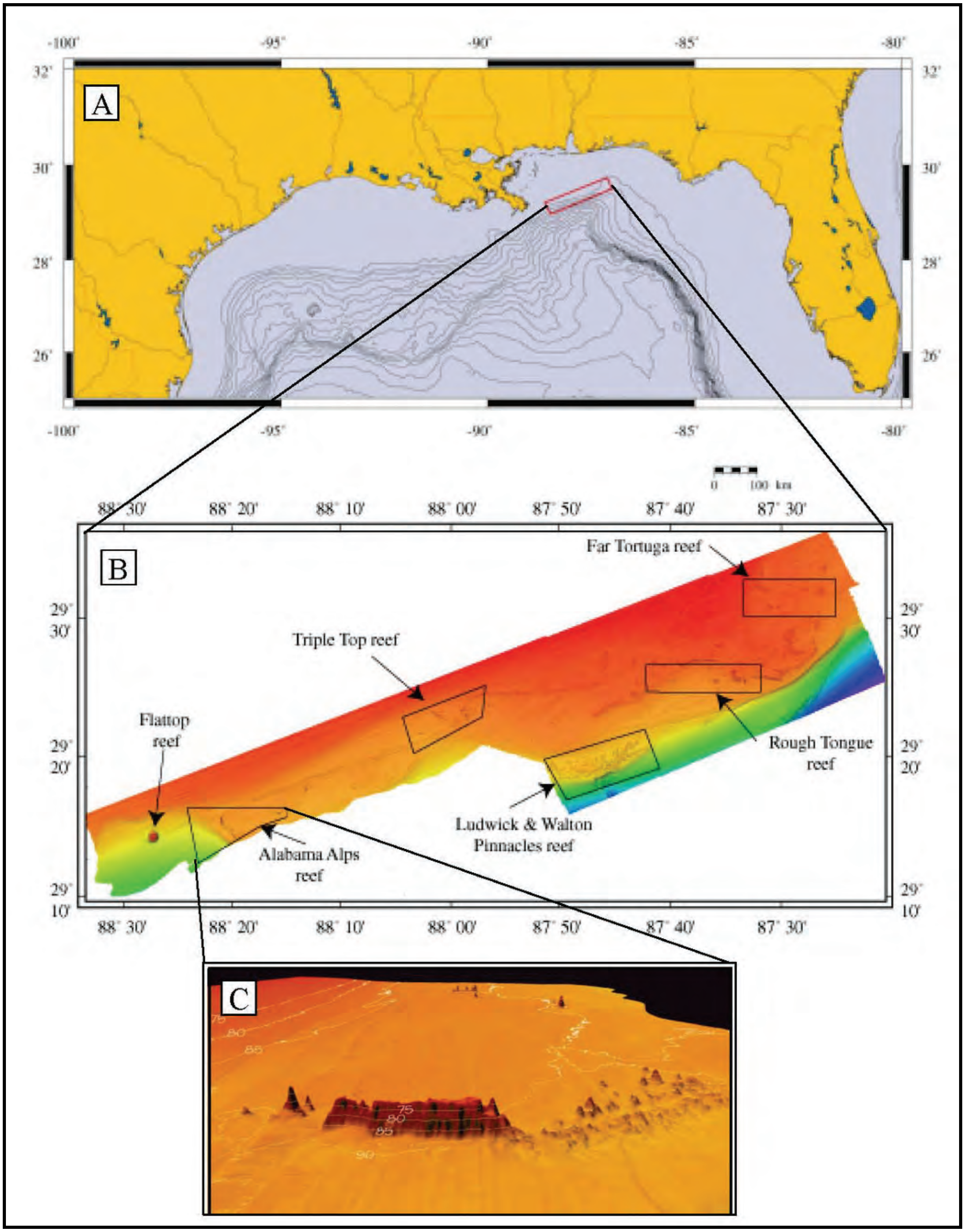

Figure 4-40. Location of the 36 Fathom Ridge within the Alabama Alps Formation (A and B) (Gardner et al., 2000) and Oblique View of the 36 Fathom Ridge within the Alabama Alps (C) (Weaver et al., 2002).

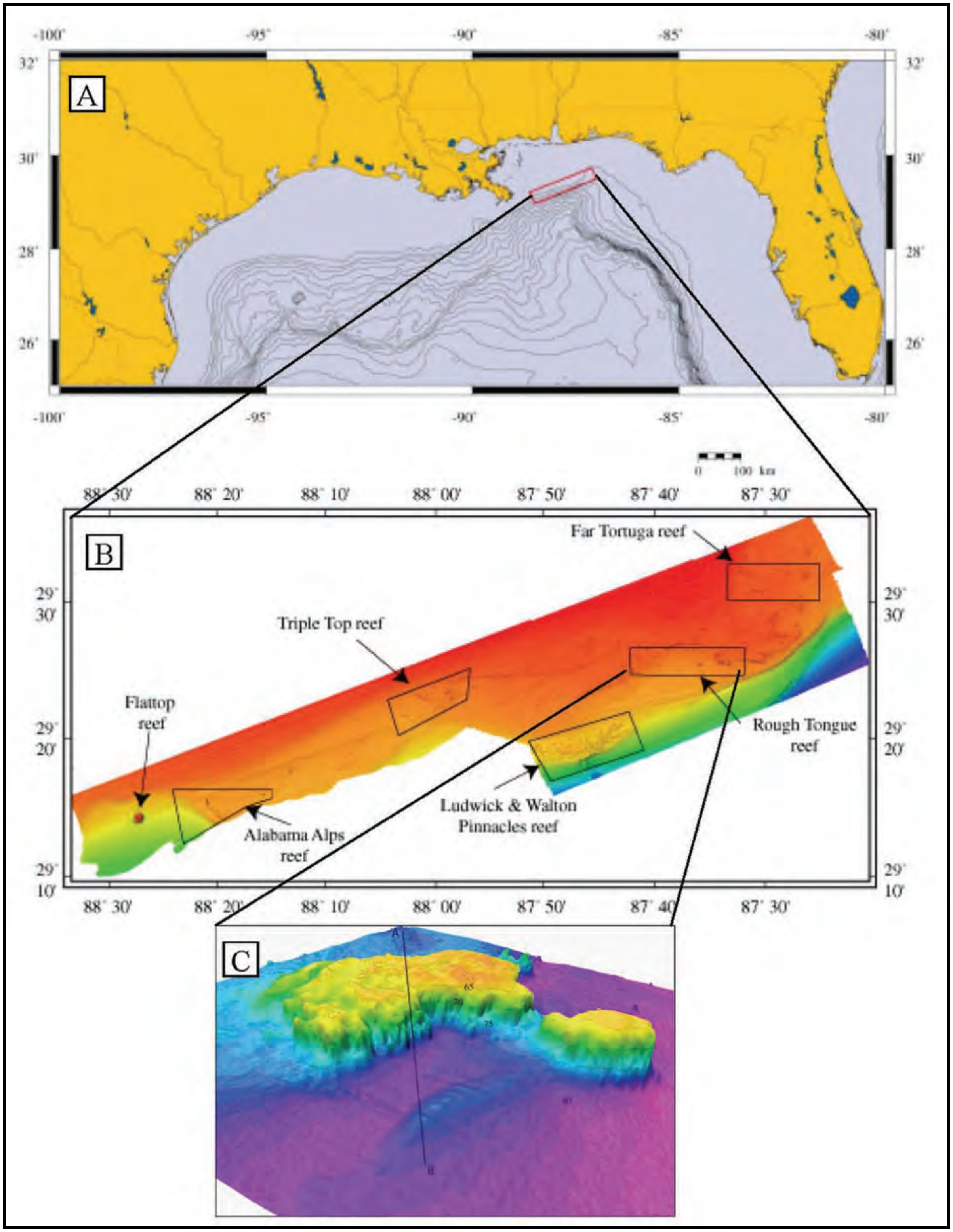

Figure 4-41. Location of Roughtongue Reef (A and B) (Gardner et al., 2000) and Oblique View of Roughtongue Reef (C) (Weaver et al., 2002).

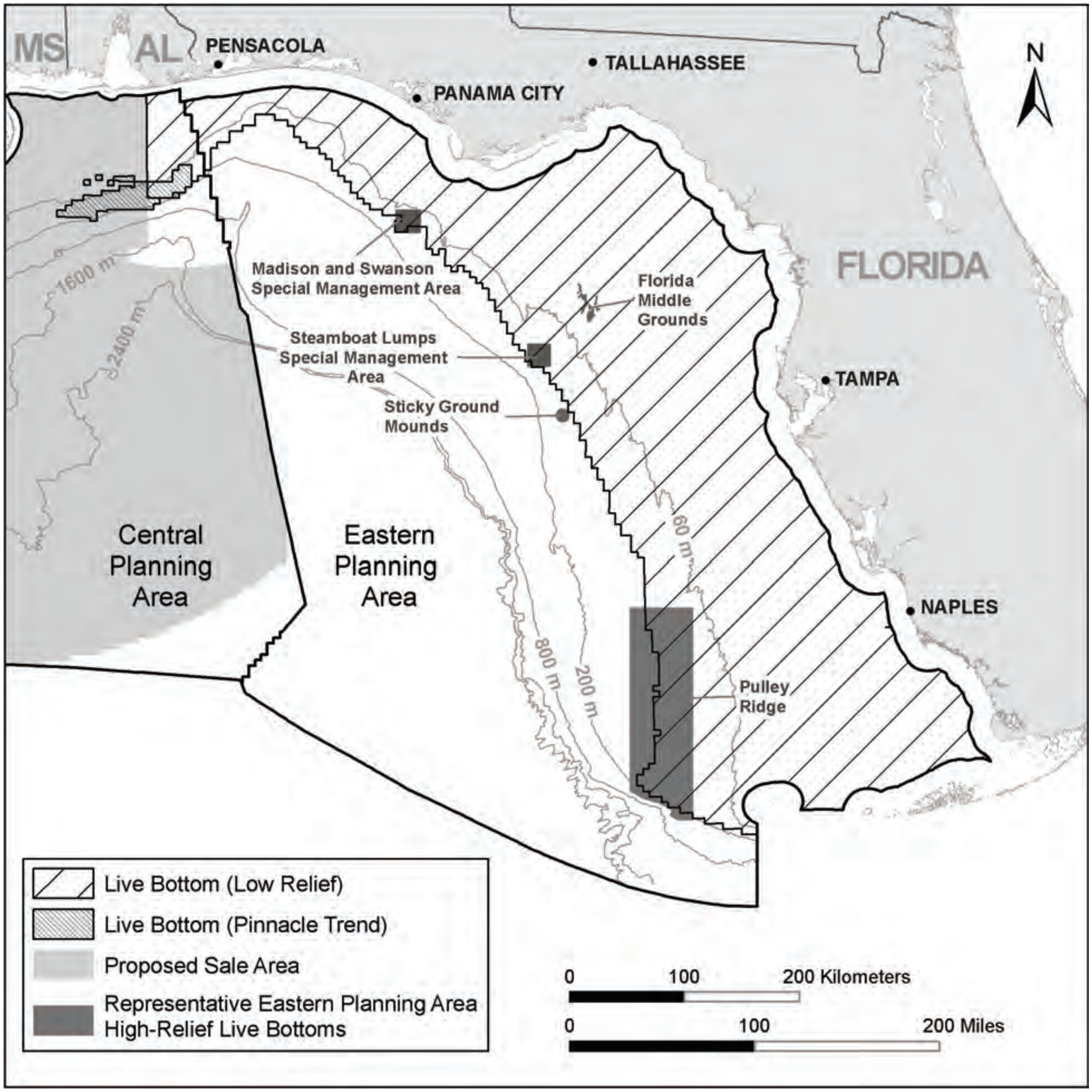

Figure 4-42. Location of Live-Bottom Features on the Mississippi, Alabama, and Florida Continental Shelf.

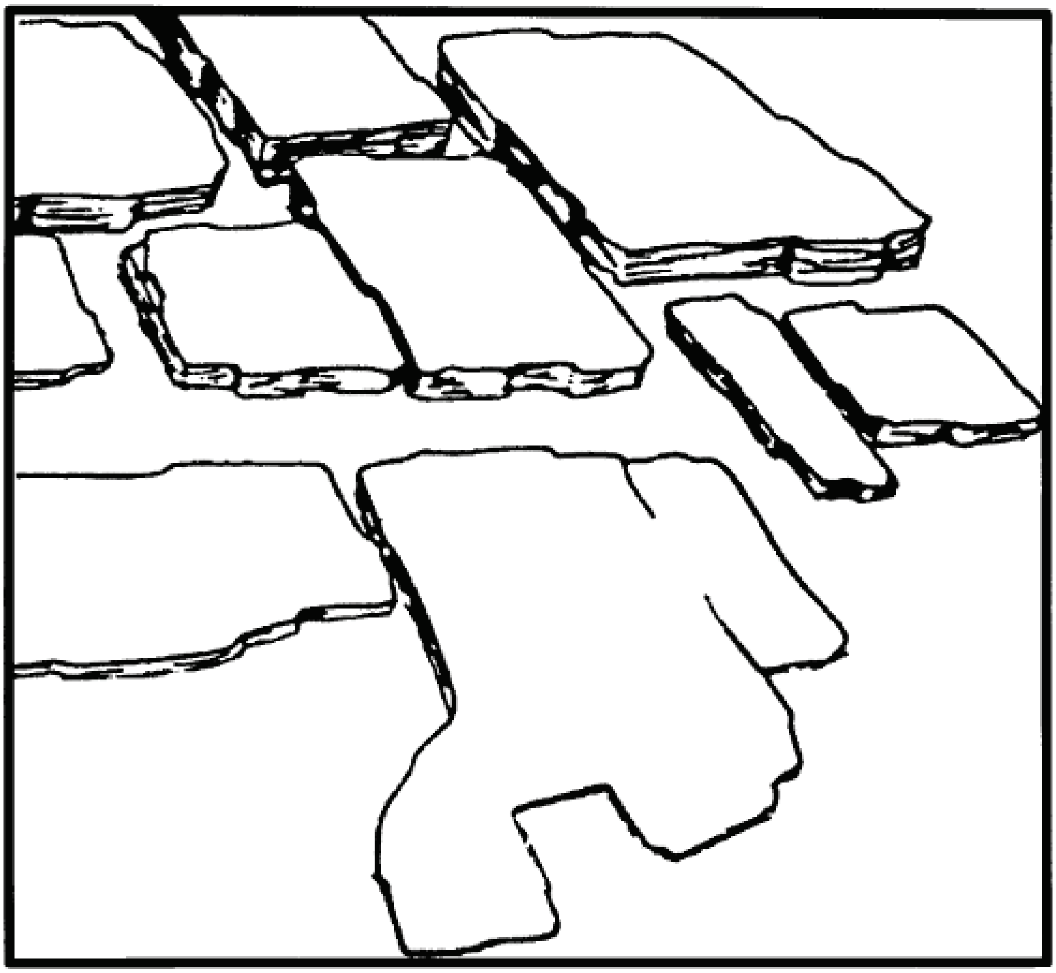

Figure 4-43. Block-Like, Hard-Bottom Substrate North of the Head of the De Soto Canyon (Shipp and Hopkins, 1978).

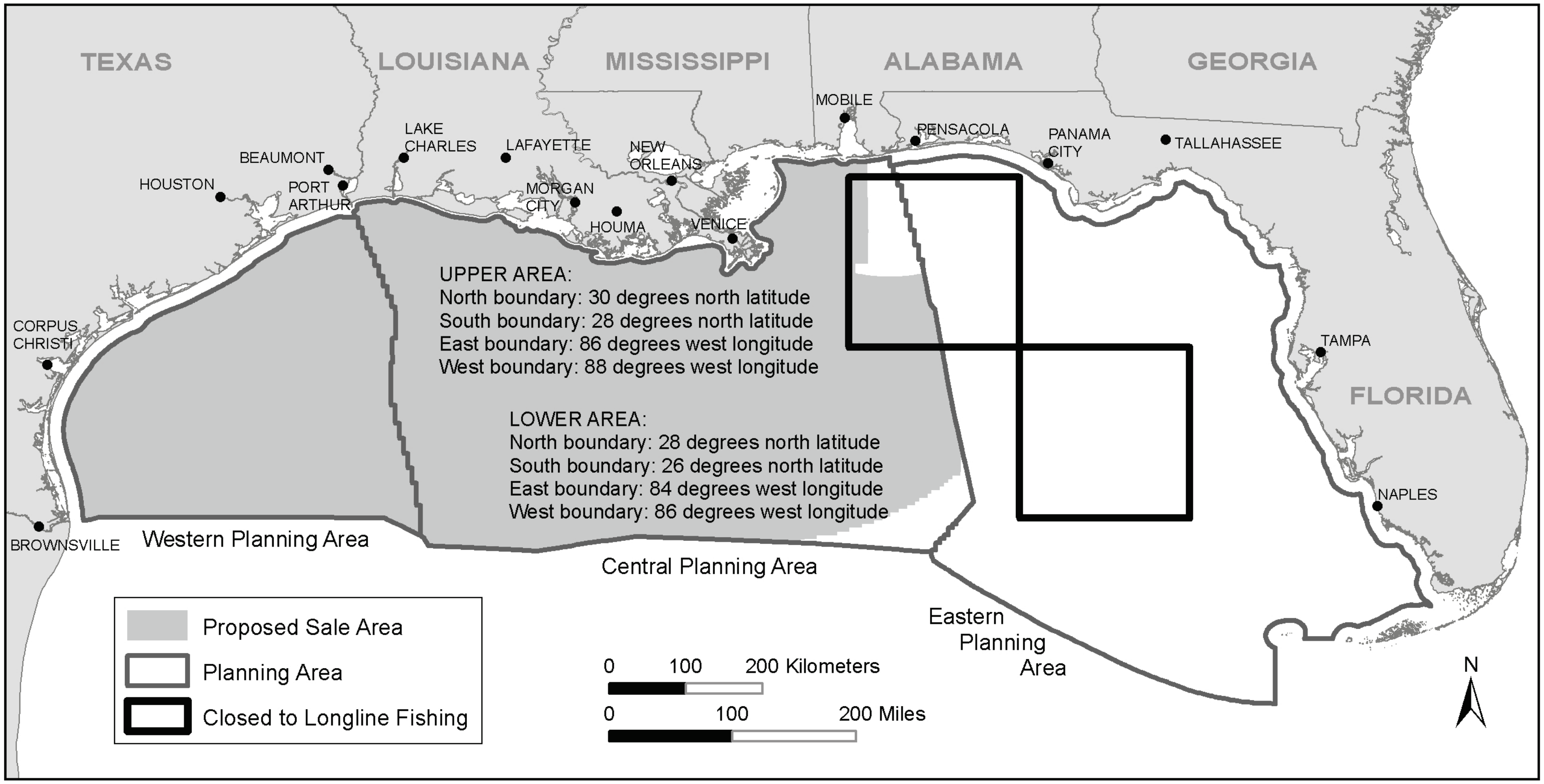

Figure 4-44. Areas Closed to Longline Fishing in the Gulf of Mexico.

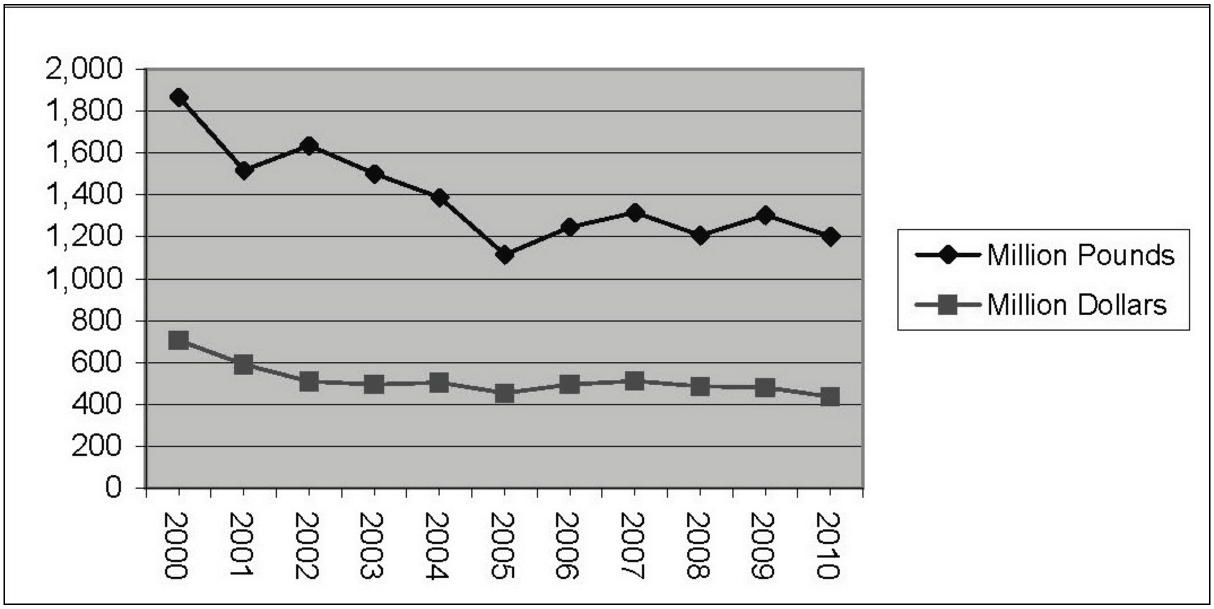

Figure 4-45. Total Commercial Fisheries (shellfish and finfish) from Louisiana, Mississippi, Alabama, and the West Coast of Florida, 2000-2010 (USDOC, NMFS, 2011b).

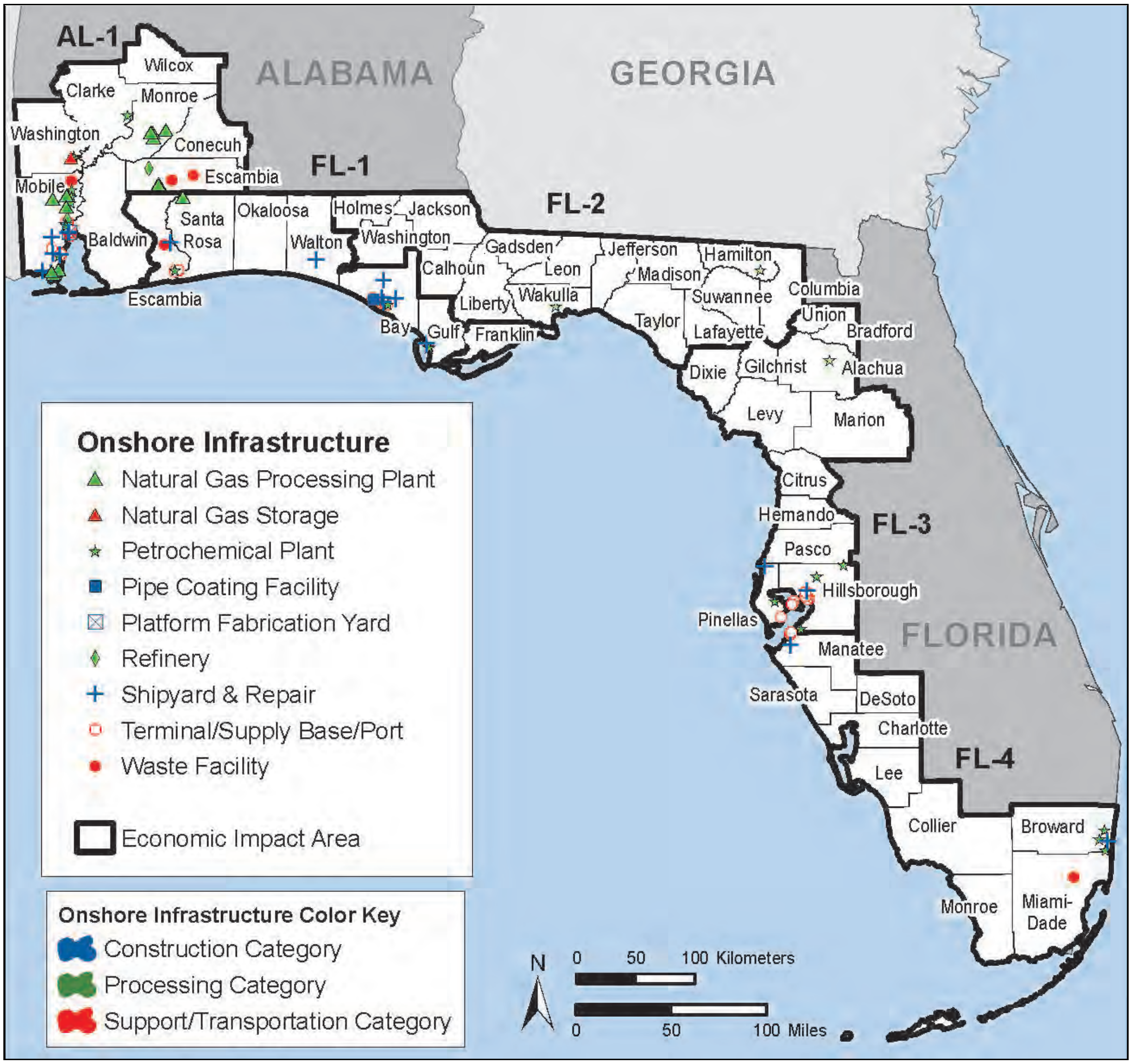

Figure 4-46. Onshore Infrastructure Located in Alabama and Florida (Dismukes, 2011).

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TABLES

Table 1-1

Proposed WPA and CPA Gulf of Mexico OCS
Lease Sale Schedule

Lease Sale No.	Area	Year
229	Western Planning Area	2012
227	Central Planning Area	2013
233	Western Planning Area	2013
231	Central Planning Area	2014
238	Western Planning Area	2014
235	Central Planning Area	2015
246	Western Planning Area	2015
241	Central Planning Area	2016
248	Western Planning Area	2016
247	Central Planning Area	2017

Table 1-2

Emergency 30 CFR 250 Subpart D Interim Final Rule Provisions

Regulation	Summary	Existing Requirement	New Requirement	Cost
30 CFR §250.415(f)	Evaluate best practices in API RP 65 Part 2	No evaluation required	Requires the operator to evaluate the best practices according to API RP 65 Part 2 and submit a written description for the evaluation	No meaningful cost
			Written description must include the mechanical barriers and cementing practices the operator will use for each casing string	
			API RP 65 Part 2 addresses cementing practices and factors affecting cementing success	
30 CFR §250.416(d)	Submittal of schematics of all control systems for BOP stack	Schematic of BOP system showing inside diameter of BOP stack, number and type of preventers, location of choke and kill lines	Schematics of all control systems, including primary controls, secondary controls, and pods for the BOP system must be submitted	No meaningful cost
			Location of the controls must be included	
30 CFR §250.416(e)	Independent third-party verification to ensure blind-shear rams are capable of cutting the drill pipe used	Information that the blind-shear ram is capable of shearing the pipe	Verification that the blind-shear rams installed in the BOP stack are capable of shearing the drill pipe in the hole under maximum anticipated surface pressure	Independent third-party certification will require a small cost per well
		No independent third-arty certification required	Independent third party must be a technical classification society or an API-licensed manufacturing, inspection, certification firm, or licensed professional engineering firm	Will add moderate costs
			Independent third party must not be the OEM	
30 CFR §250.418(i)	Submit qualifications of independent third parties with APD	No independent third party certification required	Description of qualifications in accordance with §250.416 (e)	No meaningful cost

Table 1-2. Emergency 30 CFR 250 Subpart D Interim Final Rule Provisions (continued).

<table>
<tr><th>Regulation</th><th>Summary</th><th>Existing Requirement</th><th>New Requirement</th><th>Cost</th></tr>
<tr><td rowspan="3">30 CFR § 250.420(a)(6)</td><td rowspan="3">PE verification of well casing and cementing program</td><td rowspan="3">No PE verification required</td><td>PE will verify there are two independent barriers</td><td>Small cost per well if performed by an independent third party</td></tr>
<tr><td rowspan="2">Verify the casing cementing design is appropriate for the purpose it was intended under expected wellbore conditions</td><td>No cost if PE certification is done in-house</td></tr>
<tr><td>Assumed that some majors would verify in-house; smaller operators will use third party</td></tr>
<tr><td rowspan="3">30 CFR § 250.420(b)(3)</td><td rowspan="3">Dual mechanical barriers</td><td rowspan="3">No requirement</td><td rowspan="3">Operator must install dual mechanical barriers in addition to cement in the final casing string and document to BOEM

Dual float valves, or one float valve and a mechanical plug</td><td>Estimated that 80% of wells already use dual mechanical barriers</td></tr>
<tr><td>Installation of dual mechanical barriers is estimated to take 21 hours</td></tr>
<tr><td>Will add significant costs</td></tr>
<tr><td rowspan="3">30 CFR § 250.423(b)(2)</td><td rowspan="3">Pressure test on the casing seal assembly</td><td>Perform a pressure test on all casing strings (except drive/ structural) according to 250.423(a)</td><td rowspan="3">Additional pressure test for the intermediate and production casing strings on the casing seal assembly to ensure proper installation of the casing in the subsea wellhead</td><td>Pressure tests are already required, no extra equipment time</td></tr>
<tr><td rowspan="2">No requirement to ensure proper installation of the casing in the subsea wellhead</td><td>Each pressure test only takes a few minutes</td></tr>
<tr><td>No meaningful cost</td></tr>
<tr><td>30 CFR §250.423(c)</td><td>Negative pressure test</td><td>No negative pressure test required</td><td>Perform a negative pressure test to ensure proper installation of intermediate and production casing strings</td><td>Negative pressure test will take 90 minutes for each required string of casing</td></tr>
</table>

Table 1-2. Emergency 30 CFR 250 Subpart D Interim Final Rule Provisions (continued).

Regulation	Summary	Existing Requirement	New Requirement	Cost
				Will result in significant costs for the regulation
30 CFR §250.442(e)	Maintain ROV and a trained crew	ROV's used for visual inspection every 3 days; 250.446(b)	Required to maintain an ROV and trained crew on each floating rig on a continuous basis	All rigs are assumed to have an ROV on board. This regulation will not add additional costs
			ROV must be capable of shutting in the well during emergency situations	Regulation does not require a timed test; therefore, current ROV's will be capable of performing all required functions.
30 CFR §250.442(f)	Provide an autoshear and deadman system for dynamically positioned rigs	No autoshear/deadman system requirement	All dynamically positioned rigs must have an autoshear and deadman system	Industry standard for dynamically positioned rigs to have autoshear/deadman systems
				No meaningful cost
30 CFR §250.442(g)	Barriers on BOP control panels to prevent accidental disconnect functions	No two-handed requirement	Incorporate enable buttons on control panels to ensure two-handed operations for all critical functions	No meaningful cost
30 CFR §250.442(h)	Label subsea BOP control panel	No labeling requirement	Clearly label all control panels, such as hydraulic control panels and ROV interface on the BOP	No meaningful cost
30 CFR §250.442(i)	Develop management system for BOP	No management requirement	Develop and use a management system for operating the BOP system	No meaningful cost
			Written procedures for operating the BOP stack and LMRP	

Table 1-2. Emergency 30 CFR 250 Subpart D Interim Final Rule Provisions (continued).

Regulation	Summary	Existing Requirement	New Requirement	Cost
			Minimum knowledge requirements for personnel authorized to operate and maintain critical BOP components	
30 CFR §250.442(j)	Training for BOP equipment	No training requirement	Train BOP personnel in deepwater well control theory and practice in accordance with 30 CFR 250, Subpart O	No meaningful cost
30 CFR §250.446(a)	Document maintenance and inspections to BOP system	No documentation requirement	BOP maintenance and inspections must meet or exceed provisions of Sections 17.10 and 18.10	No meaningful cost
30 CFR §250.449(j)	Subsea function test for ROV intervention on a subsea BOP stack	No initial test on the seafloor	All ROV intervention functions must be tested during the stump test and one set of rams during the initial test on the seafloor	Initial test on the seafloor is not industry standard
		Stump test for subsea BOP stack	ROV hot stabs must be function tested and capable of actuating at least 1 set of pipe rams, 1 set of blind-shear rams and unlatching the LMRP	ROV seafloor test is estimated to take about 24 hours
			Operator must examine all surface and subsea well control equipment to ensure that it is properly maintained and capable of shutting in the well during emergency operations	Will add significant costs
30 CFR §250.449(k)	Autoshear/ deadman function test	No required function test	Autoshear and deadman systems must be function tested during the stump test and during the initial test on the seafloor	No meaningful cost
30 CFR §250.451(i)	Emergency activation of blind or casing shear rams	No required action	If the blind-shear or casing shear rams are activated in a well control situation, then the BOP must be retrieved and fully inspected and tested	Emergency situation only, will incur significant loss of rig time
30 CFR §250.456(j)	District Manager approval for displacing kill-weight drilling fluid	No approval requirement	Approval required from District Manager before displacing kill-weight drilling fluid from the wellbore	No meaningful cost
			Submit reasons for displacing and provide detailed procedures of displacement process	
			Follow procedures in 250.456	

Table 1-2. Emergency 30 CFR 250 Subpart D Interim Final Rule Provisions (continued).

Regulation	Summary	Existing Requirement	New Requirement	Cost
30 CFR § 250.516(d)(8)	Subsea function test for ROV intervention on a subsea BOP stack	Stump test BOP stack before installation	All ROV intervention functions must be tested during the stump test and one set of rams during the initial test on the seafloor	Will add costs for well completions operations
			ROV hot stabs must be function tested and capable of actuating at least 1 set of pipe rams, 1 set of blind-shear rams and unlatching the LMRP	
			Operator must examine all surface and subsea well control equipment to ensure that it is properly maintained and capable of shutting in the well during emergency operations	
30 CFR § 250.616(h)(1)	Subsea function test for ROV intervention on a subsea BOP stack	Stump test BOP stack before installation	All ROV intervention functions must be tested during the stump test and 1 set of rams during the initial test on the seafloor	Will add costs for well workover operations
			ROV hot stabs must be function tested and capable of actuating at least 1 set of pipe rams, 1 set of blind-shear rams and unlatching the LMRP	
			Operator must examine all surface and subsea well control equipment to ensure that it is properly maintained and capable of shutting in the well during emergency operations	

BOP = blowout preventer
LMRP = lower marine riser package
PE = professional engineer
ROV = remotely operated vehicle

Table 1-3

Overview of the Assignment of Regulations between the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement

Title 30—Mineral Resources		
Current Part	New Location	Note*
Part 203 – Relief or Reduction in Royalty Rates	Retained in its entirety in BSEE, Chapter II.	The BSEE will oversee the administration of royalty relief awarded after lease issuance as an operational responsibility. However, BOEM will set the terms and conditions of any future leases issued with royalty relief provisions.
Part 219 – Distribution and Disbursement of Royalties, Rentals, and Bonuses	Moved in its entirety to BOEM, Chapter V, Part 519.	The BOEM will perform revenue share calculations for OCS receipts shared under the Gulf of Mexico Energy Security Act. The Office of Natural Resources Revenue will continue to distribute the revenue shares to Gulf producing States and Coastal Political Subdivisions.
Title 30 Subchapter B—Offshore		
Part 250 – Oil and Gas and Sulphur Operations in the Outer Continental Shelf (OCS)	Responsibilities divided between BOEM and BSEE.	Both BOEM and BSEE have responsibilities that are related to operations on OCS leases. These responsibilities were divided between the two bureaus as detailed in Table B.
Part 251 – Geological and Geophysical (G&G) Explorations of the OCS	Responsibilities divided between BOEM and BSEE.	The BOEM will be responsible for issuing the permits and notices and for overseeing the activities under the approved permit, as these are prelease, resource assessment-related activities. The BSEE will be responsible for issuing permits for test drilling activities under their responsibilities for operations. Further details are provided in Table C.
Part 252 – OCS Oil and Gas Information Program	Both BOEM and BSEE will have this part in its entirety.	Part 252 regulates how and when the date and information is released by the OCS Oil and Gas Information Program. Since both bureaus will collect, maintain, and use data and information collected under this program, both are responsible for managing the data and determining how and when the data and information are released. Further details are provided in Table D.
Part 253 – Oil Spill Financial Responsibility for Offshore Facilities	Moved to BOEM in its entirety, Chapter V, Part 553.	The BOEM is responsible for all activities related to financial assurance. Oil-spill financial responsibility requirements are mandated by the Oil Pollution Act of 1990. This Act applies to oil-handling activities at any offshore facility (whether or not involved in oil production) seaward of the coastline. Further details are provided in Table E.
Part 254 – Oil-Spill Response Requirements for Facilities Located Seaward of the Coast Line	Retained in its entirety in BSEE.	All oil-spill related activities, except for financial responsibility, will fall under BSEE, under its responsibility for oil-spill response. Further details are provided in Table F.

Table 1-3. Overview of the Assignment of Regulations between the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement (continued).

Title 30 Subchapter B—Offshore (continued)		
Part 256 – Leasing of Sulphur or Oil and Gas in the OCS	Responsibilities divided between BOEM and BSEE.	The BOEM has primary responsibility for leasing and leasing-related activities. Some responsibilities related to operations and production will be in both bureaus. Suspension-related requirements will go to BSEE. Further details are provided in Table G.
Part 259 – Mineral Leasing: Definitions	Moved to BOEM in its entirety, Chapter V, Part 559.	The BOEM is responsible for leasing activities. Further details are provided in Table H.
Part 260 – OCS Oil and Gas Leasing	Moved to BOEM in its entirety, Chapter V, Part 560.	The BOEM is responsible for leasing activities. Further details are provided in Table I.
Part 270 – Nondiscrimination in the OCS	Both BOEM and BSEE will have this part in its entirety.	Both BOEM and BSEE are responsible for ensuring that lessees and operators comply with Section 604 of the OCSLA of 1978, which provides that "no person shall, on the grounds of race, creed, color, national origin, or sex, be excluded from receiving or participating in any activity, sale, or employment, conducted pursuant to the provisions of the OCSLA." Further details are provided in Table J.
Part 280 – Prospecting for Minerals Other Than Oil, Gas, and Sulphur on the OCS	Moved to BOEM in its entirety, Chapter V, Part 580.	This part regulates prospecting activities or scientific research activities on the OCS in Federal waters related to hard minerals on unleased lands or on lands under lease to a third party. These activities fall under BOEM's responsibilities for managing the development of offshore resources and activities on unleased land or on lands leased to a third party. Further details are provided in Table K.
Part 281 – Leasing of Minerals Other Than Oil, Gas, and Sulphur in the OCS	Moved to BOEM in its entirety, Chapter V, Part 581.	This part regulates leasing for minerals other than oil, gas, and sulphur in the OCS. Leasing activities are a BOEM responsibility. Further details are provided in Table L.
Part 282 – Operations in the OCS for Minerals Other Than Oil, Gas, and Sulphur	Responsibilities divided between BOEM and BSEE.	Both BOEM and BSEE have responsibilities for operations conducted under a mineral lease for OCS minerals other than oil, gas, or sulphur. These responsibilities were divided between the two bureaus as detailed in Table M.
Part 285 – Renewable Energy and Alternate Uses of Existing Facilities on the OCS	Moved to BOEM in its entirety, Chapter V, Part 585.	At this time, the renewable energy program will be managed under BOEM. At a later date, the renewable energy program will be reorganized and a determination will be made regarding what functions will be administered by which bureau.
Title 30 Subchapter C—Appeals		
Part 290 – Appeal Procedures	Both BOEM and BSEE will have this part in its entirety.	Appeal procedures apply to decisions and orders issued by both BOEM and BSEE. Further details are provided in Table O.
Part 291 – Open and Nondiscriminatory Access to Oil and Gas Pipelines under the OCS Lands Act	Retained in its entirety in BSEE.	This part deals with access to pipelines. All aspects of pipelines, including operations, are under the responsibility of BSEE. Further details are provided in Table P.

* Tables B through P are found in the *Federal Register* (2011).

Table 2-1

Alternatives Tracking

Proposed Alternative	Source of Concern	Detailed Discussion	Decision
Alternative A—The Proposed Actions		Chapters 2.2.1.1, 2.2.1.2, 4.1, and 4.2	Considered in detail
Alternative B—The Proposed Actions Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features	Areawide leasing except for blocks around topographic features	Chapters 2.2.1.1, 2.2.1.2, 4.1, and 4.2	Considered in detail
Alternative C—No Action	No leasing	Chapters 2.2.1.1, 2.2.1.2, 4.1, and 4.2	Considered in detail
Exclude Deep Water and Limit Leasing to Shallow Waters	Deepwater drilling is inherently riskier	Chapters 2.2.1.1 and 2.2.1.2	Considered but not analyzed in detail
Delay Leasing until Drilling Safety is Improved	Regulatory and technological changes to improve safety have not been sufficient	Chapters 2.2.1.1 and 2.4.1.1	Considered but not analyzed in detail
Do Not Allow Drilling in Areas with Strong Ocean Currents Such as the Loop Current	Major ocean currents could entrain and transport oil to otherwise unaffected areas, such as the Atlantic Ocean	Chapters 2.2.1.1 and 2.4.1.1	Considered but not analyzed in detail
Delay Leasing Until the State of the Gulf of Mexico Environmental Baseline is Known	State of recovery or resilience of post-DWH Gulf environmental baseline is not known	Chapters 2.2.1.1 and 2.4.1.1	Considered but not analyzed in detail
Identify and Protect Sensitive Ecosystems	More ecologic areas need to be identified and protected	Chapters 2.2.1.1 and 2.4.1.1	Considered but not analyzed in detail

Table 2-2

Gulf of Mexico OCS Loss of Well Control Incidents by Water Depth, 2006-2010

Loss of Well Control Incident	2006		2007		2008		2009		2010	
	GOM	Water Depth (ft)	GOM	Water Depth (ft)	GOM	Water Depth (ft)	GOM	Water Depth (ft)	GOM	Water Depth (ft)
Flow Underground			1	54	1	483				
Flow to Surface			3	51 37 92	3	50 7,005 100	2	2,013 24	1	4,992
Diverter Flow					1	287				
Surface Equipment Failure	2	189 50	3	243 158 15	3	35 132	4	76 169 2,032 6,050	3	3,330 182 283

Source: USDOI, BOEMRE, 2011a.

Table 2-3

All OCS Blowout Incidents by Water Depth,
1971-1991, 1992-2006, and 2007-2011

Panel A.	All OCS Blowout Incidents by Water Depth, 1971-1991				
Water Depth (ft)	Exploration Wells	Development Wells	Total Wells	Total Blowouts	Wells Drilled per Blowout
0-200	4,744	8,120	13,012	39	334
201-500	2,312	4,559	6,960	38	183
501-1,000	395	351	746	8	93
>1,000	496	222	718	2	359
Total All Depths	7,947	13,292	21,436	87	246 average rate

Source: Danenberger, 1993 (Table 1).

Panel B.	All OCS Blowout Incidents by Water Depth, 1992-2006				
Water Depth (ft)	Exploration Wells	Development Wells	Total Wells	Total Blowouts	Wells Drilled per Blowout
0-200	3,156	5,566	8,722	19	459
201-500	965	2,251	3,216	14	230
501-1,000	203	443	646	1	646
>1,000	1,347	1,146	2,493	5	499
Total All Depths	5,671	9,406	15,077	39	387 average rate

Source: Izon et al., 2007 (Table 1).

Panel C.	All OCS Blowout Incidents by Water Depth, 2007-2011				
Water Depth (ft)	Exploration Wells	Development Wells	Total Wells	Total Blowouts	Wells Drilled per Blowout
0-200	381	669	1,050	18	58
201-500	468	936	1,404	6	234
501-1,000	7	4	11	0	0
>1,000	396	197	593	8	74
Total All Depths	1,252	1,806	3,058	32	96 average rate

Source: Izon, official communication, 2012.
Please note that reporting requirements for loss of well control changed in July 2006.

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	0.0502

BBO = billion barrels of oil
Tcf = trillion cubic feet

Table 3-2

Offshore Scenario Information Related to a Typical Lease Sale in the Western Planning Area

	Offshore Subareas[1]						
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	Total WPA[2]
Wells Drilled							
Exploration and Delineation Wells	23-38	7-12	9-16	8-13	3-5	3-5	53-89
Development and Production Wells	30-49	11-17	13-21	11-18	6-8	6-8	77-121
Producing Oil Wells	4-6	2	8-13	7-11	3-4	3-4	27-40
Producing Gas Wells	22-37	7-12	3-5	2-4	1-2	1-2	36-62
Production Structures							
Installed	10-17	1-2	1	1	1	1	15-23
Removed Using Explosives	7-12	1	0	0	0	0	7-13
Total Removed	9-16	1-2	1	1	1	1	14-22
Method of Transportation[3]							
Percent Piped	>99%	>99%	>99%	>99%	83->99%		94->99%
Percent Barged	<1%	0%	0%	0%	0%		<1%
Percent Tankered[4]	0%	0%	0%	0%	0-17%		0-5%
Length of Installed Pipelines (km)[5]	71-182	NA	NA	NA	NA	NA	237-554
Service-Vessel Trips (1,000's round trips)	21-33	2-3	2-3	17	16-17	16-17	64-75
Helicopter Operations (1,000's operations)	194-448	19-54	19-24	19-24	19-24	19-24	290-605

[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] Projected length of pipelines does not include length in State waters.

NA = not available.

Table 3-3

Offshore Scenario Information Related to a Typical Lease Sale in the Central Planning Area

	Offshore Subareas[1]						
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	Total CPA[2]
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] 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 Gulf of Mexico (WPA, CPA, and EPA) for 2012-2051

	Offshore Subareas[1]						
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	Total OCS[2]
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] Projected length of pipelines does not include length in State waters.

NA = not available.

Table 3-5

Offshore Scenario Information Related to OCS Program Activities
in the Western Planning Area for 2012-2051

	Offshore Subareas[1]						
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	Total WPA[2]
Wells Drilled							
Exploration and Delineation Wells	500-740	170-230	220-320	160-230	70-90	60-80	1,180-1,690
Development and Production Wells	620-920	220-290	270-400	190-290	80-120	70-100	1,450-2,120
Producing Oil Wells	74-109	27-38	170-255	125-191	54-77	45-67	495-737
Producing Gas Wells	476-711	163-222	70-105	45-69	16-23	15-23	785-1,153
Production Structures							
Installed	220-330	20-30	6-10	5-8	2-3	2-3	255-384
Removed Using Explosives	146-219	14-21	1	0	0	0	160-240
Total Removed	200-300	20-30	6-8	4-7	2-3	1-2	233-350
Method of Transportation[3]							
Percent Piped	>99%	>99%	>99%	>99%	50->99%		84->99%
Percent Barged	<1%	0%	0%	0%	0%		<1%
Percent Tankered[4]	0%	0%	0%	0%	0-50%		0-15%
Length of Installed Pipelines (km)[5]	1,967-4,128	NA	NA	NA	NA	NA	5,224-12,339
Service-Vessel Trips (1,000's round trips)	249-372	35-50	26-36	95-150	38-57	38-56	481-720
Helicopter Operations (1,000's operations)	4,489-8,987	418-836	125-272	104-209	42-84	42-84	5,220-10,450

[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] Projected length of pipelines does not include length in State waters.

NA = not available.

Table 3-6

Offshore Scenario Information Related to OCS Program Activities
in the Central Planning Area for 2012-2051

	Offshore Subareas[1]						
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	Total CPA[2]
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] Projected length of pipelines does not include length in State waters.

NA = not available.

Table 3-7

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

Source: USDOI, BOEMRE, 2010.

Table 3-8

Average Annual Inputs of Petroleum Hydrocarbons
to Coastal Waters of the Gulf of Mexico, 1990-1999

Inputs	Western Gulf of Mexico		Eastern Gulf of Mexico	
	(tonnes)	(bbl)	(tonnes)	(bbl)
Extraction of Petroleum				
Platforms Spills	90	630	trace[1]	trace
Atmospheric Releases (VOC's)	trace	trace	trace	trace
Permitted Produced-Water Discharges	590	4,130	trace	trace
Sum of Extraction Inputs	680	4,760	trace	trace
Transportation of Petroleum				
Pipelines Spills	890	6,230	trace	trace
Tank Vessel Spills	770	5,390	140	980
Coastal Facilities Spills[2]	740	5,180	10	70
Atmospheric Releases (VOC's)[3]	trace	trace	trace	trace
Sum of Transportation Inputs[4]	2,400	16,800	160	1,120
Consumption of Petroleum				
Land-Based Sources[5]	11,000	77,000	1,600	11,200
Recreational Vessels	770	5,390	770	5,390
Vessel >100 GT (spills)	100	700	30	210
Vessel >100 GT (operational discharges)	trace	trace	trace	trace
Vessel <100 GT (operational discharges)	trace	trace	trace	trace
Deposition of Atmospheric Releases (VOC's)	90	630	60	420
Aircraft Jettison of Fuel	NA	NA	NA	NA
Sum of Consumption	12,000	84,000	2,500	17,500

[1]Trace indicates <70 bbl (10 tonnes).
[2]Coastal facility spills do not include spills in coastal waters related to exploration and production spills or spills from vessels. The category "Coastal Facilities" includes aircraft, airport, refined product in coastal pipeline, industrial facilities, marinas, marine terminals, military facilities, municipal facilities, reception facilities, refineries, shipyards, and storage tanks.
[3]Volatization of light hydrocarbons during tank vessel loading, washing, and voyage.
[4]Sums may not match.
[5]Inputs from land-based sources during consumption of petroleum are the sum of diverse sources. Three categories of wastewater discharge are summed: municipal; industrial (not related to petroleum refining); and petroleum refinery wastewater. Urban runoff is included. It results from oil droplets from vehicles washing into waterways from parking lots and roads, and the improper disposal of oil containing consumer products.
GT = gross tons.
NA = not available.
VOC's = volatile organic compounds.

Source: NRC, 2003.

Table 3-9

Average Annual Inputs of Petroleum Hydrocarbons
to Offshore Waters of the Gulf of Mexico, 1990-1999

Inputs	Western Gulf of Mexico		Eastern Gulf of Mexico	
	(tonnes)	(bbl)	(tonnes)	(bbl)
Natural Sources				
Seeps	70,000	490,000	70,000	490,000
Extraction of Petroleum				
Platforms Spills	50	350	trace[1]	trace
Atmospheric Releases (VOC's)	60	420	trace	trace
Permitted Produced-Water Discharges	1,700	11,900	trace	trace
Sum of Extraction	1,800	12,600	trace	trace
Transportation of Petroleum				
Pipelines Spills	60	420	trace	trace
Tank Vessels Spills	1,500	10,500	10	70
Atmospheric Releases (VOC's)	trace	trace	trace	trace
Sum of Transportation	1,600	11,200	10	70
Consumption of Petroleum				
Land-Based Consumption[2]	NA	NA	NA	NA
Recreational Vessel Consumption[3]	NA	NA	NA	NA
Vessel >100 GT (spill)	120	840	70	490
Vessel >100 GT (operational discharges)	25	175	trace	trace
Vessel <100 GT (operational discharges)	trace	trace	trace	trace
Deposition of Atmospheric Releases (VOC's)	1,200	8,400	1,600	11,200
Aircraft Jettison of Fuel	80	560	80	560
Sum of Consumption4	1,400	9,800	1,800	12,600

[1]Trace indicates <70 bbl (10 tonnes).
[2]Limited to coastal zone.
[3]Limited to within 3 mi (5 km) of the coast.
[4]Sums may not match.
GT = gross tons.
NA = not available.
VOC's = volatile organic compounds.

Source: NRC, 2003.

Table 3-10

Estimated Global Average Annual Inputs of Oil Entering the Marine Environment
from Ships and Other Sea-Based Activities, 1988-1997

Source	Metric Tonnes per Year	bbl per Year	Percent of Total
Ships	457,000	3,199,000	37%
Offshore Exploration and Production	20,000	140,000	2%
Coastal Facilities	115,000	805,000	9%
Small Craft Activity	53,000	371,000	4%
Natural Seeps	600,000	4,200,000	48%
Unknown (unidentified) Sources	200	1,400	0%
Total	1,245,200	8,716,400	100%

Source: GESAMP, 2007.

Table 3-11

Annual Summary of Number and Total Volume of Oil Spilled into the Gulf of Mexico, 2001-2009

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)

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: Dickey, official communication, 2011.

Table 3-12

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 WPA or CPA Proposed Action Over a 40-Year Time Period

Spill Size Group	Spill Rate (spills/BBO)[1]	Number of Spills Estimated for a WPA Proposed Action	Number of Spills Estimated for a CPA Proposed Action	Estimated Median Spill Size (bbl)[1]
0-1.0 bbl	2,020	234-404	929-1,806	<0.024
1.1-9.9 bbl	57.4	7-11	26-51	3.0
10.0-49.9 bbl	17.4	2-3	8-16	
50.0-499.9 bbl	11.3	1-2	5-10	130
500.0-999.9 bbl	1.63	<1	<1-1	
≥1,000-9,999 bbl	1.13	<1	<1-1	2,200
≥10,000 bbl	0.31	<1	<1	---[2]
Catastrophic Spill Event	---[3]	---[3]	---[3]	4,900,000

Notes: The number of spills estimated is derived by application of the historical rate of spills per volume crude oil handled (1996-2010) (USDOI, BOEMRE, 2011b) to the projected production for a WPA or CPA proposed action (**Table 3-1**). The actual number of spills that may occur in the future could vary from the estimated number.

[1] Source: USDOI, BOEMRE, 2011b, and calculations based on data therein. The spill rates presented are a sum of rates for U.S. OCS platforms/rigs and pipelines. The average (vs. the median) spill sizes for a larger number of spill size categories can also be found in the original source.
[2] During the last 15 years, the only ≥10,000 bbl spill was the *Deepwater Horizon*. However, this spill is considered to be a low-probability catastrophic event (**Appendix B**), and so it has been included in the "Catastrophic Spill Event" category in this table.
[3] The catastrophic spill event is considered to have a low probability of occurrence (**Appendix B**).

Table 3-13

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
Pipecoating 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] USDOI, BOEMRE, 2011c.
[2] Dismukes, 2011.

Table 3-14

Waterway Depth, Traffic, and Number of Trips for 2009

Waterway	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
			Foreign	Domestic
Gulf Intracoastal Waterway (GIWW)				
Pensacola Bay, Florida, to Mobile Bay, Alabama	12	4,838	0	8,231
Mobile Bay, Alabama, to New Orleans, Louisiana	12, 14	18,293	0	37,046
Mississippi River, Louisiana, to Sabine River, Texas	12, 10	62,422	0	115,965
Sabine River, Texas, to Galveston, Texas	12	54,322	0	62,143
Galveston, Texas, to Corpus Christi, Texas	11, 10, 2	20,631	0	39,577
Corpus Christi, Texas, to Mexican Border, Texas	10, 12, 7	1,423	0	2,256
Texas Harbors, Channels, and Waterways				
Beaumont (Neches River)	39, 40, 32	67,715	1,970	24,886
Port Arthur	38	33,804	1,551	13,249
Sabine Pass Harbor	29	753	63	3,061
Sabine-Neches Waterway	40, 37, 39, 32, 27, 20, 9, 8	127,831	3,641	70,352
Louisiana Harbors, Channels, and Waterways				
Atchafalaya River (Upper), Louisiana*	12	11,660	6	26,918
Atchafalaya River (Lower), Louisiana*	20	1,960	1,866	38,433
Barataria Bay Waterway	17,10	143	2	5,493
Bayou Lafourche and Lafourche-Jump Waterway	28, 27, 27, 9	4,950	5,845	29,778
Bayou Little Caillou	4,5,1	172	0	1,820
Bayou Teche and Vermilion River	8, 11, 9, 8, 5	881	6	5,499
Calcasieu River and Pass (Lake Charles)	42, 41-42, 36, 12, 7	43,581	3,378	60,366
Freshwater Bayou	12	1,116	101	18,608
GIWW, Morgan City-Port Allen Route	10	16,402	0	20,950
Inner Harbor Navigation Canal	30, 15	14,770	121	17,298
Mermentau River	4, 7, 12, 10, 9, 11, 6, 8, 4, 7	487	0	4,403
Mississippi River Gulf Outlet via Venice Vicinity	16, 14	1,657	45	13,270
Port of Baton Rouge	45, 40, 9, 12	51,869	1,011	68,332
Port of New Orleans	45, 30, 32, 36, 37, 12	68,126	3,891	46,393
Port of Plaquemines	45	50,869	1,300	108,031
Port of South Louisiana	45	212,581	3,831	125,018
Waterway from Empire to Gulf of Mexico	6, 9, 14	889	0	14,145
Waterway from GIWW to Bayou Dulac	8, 6	73	14	2,242
Mississippi Harbors, Channels, and Waterways				
Bayou Casotte	38	35,804	1,116	5,476
Pascagoula Harbor	40, 38, 38, 22, 12	36,618	1,351	5,879
Alabama Harbors, Channels, and Waterways				
Black Warrior and Tombigbee Rivers	9	15,708	0	24,214
Chickasaw Creek	25	989	79	1,036
Dauphin Island Bay	10 and less	45	2	13,226
Mobile Harbor	47, 45, 40, 13-39, 40	52,219	2,712	37,513
Tennessee Tombigbee Waterway	9	5,781	0	8,846
Theodore Ship Channel	40	4,432	134	4,004

*Name change in 2009.

Source: LaMarca, official communication, 2011.

Table 3-15

OCS-Related Service Bases

Texas		
TX1-1	TX-2	TX-3
Aransas Pass (Nueces) Bayside (Aransas) Corpus Christi (Nueces) Harbor Island (Nueces) Ingleside (San Patricio) Port Aransas (Nueces) Port Isabel (Cameron) Port Mansfield (Willacy) Rockport (Aransas)	Freeport (Brazoria) Port O'Connor (Calhoun)	Galveston (Galveston) Pelican Island (Galveston) Port Arthur (Jefferson) Sabine Pass (Jefferson) Surfside (Harris)

Louisiana			
LA-1	LA-2	LA-3	LA-4
Cameron (Cameron) Grand Chenier (Cameron) Lake Charles (Calcasieu)	Abbeville (Vermilion) Erath (Vermilion) Freshwater City (Vermilion) Intracoastal City (Vermilion) Kaplan (Vermilion) New Iberia (Iberia) Weeks Island (Iberia)	Amelia (St. Mary) Bayou Boeuf (St Mary) Berwick (St. Mary) Cocodrie (Terrebonne) Dulac (Terrebonne) Fourchon (Lafourche) Gibson (Terrebonne) Houma (Terrebonne) Leeville (Lafourche) Louisa (St. Mary) Morgan City (St. Mary) Patterson (St. Mary) Theriot (Terrebonne)	Empire (Plaquemines) Grand Isle (Jefferson) Harvey (Jefferson) Hopedale (St. Bernard) Paradis (St. Charles) Venice (Plaquemines)

Mississippi and Alabama	
MS-1	AL-1
Pascagoula (Jackson)	Bayou LaBatre (Mobile) Mobile (Mobile) Theodore (Mobile)

Florida			
FL-1	FL-2	FL-3	FL-4
Panama City (Bay)	NA	NA	NA

Note: The county or parish in which the service base is located is noted in parentheses.
NA = not available.

Source: USDOI, BOEMRE, 2011c.

Table 3-16

OCS Pipeline Landfalls Installed Since 1996

Segment Number	Year of Installation*	Product Type	Size	Company	State
10631	1996	Oil	24"	Equilon Pipeline Company LLC	LA
12470	1996	Oil	24"	Manta Ray Gathering Company LLC	LA
11217	1997	Gas	30"	Enbridge Offshore	LA
11496	1997	Oil	12"	ExxonMobil Pipeline Company	LA
11952	2000	Oil	18-20"	ExxonMobil Pipeline Company	TX
14470	2004	Oil	10"	Chevron USA Inc.	LA
13972	2004	Oil	24"	Manta Ray Gathering Company LLC	TX
13987	2004	Oil	24"	Manta Ray Gathering Company LLC	TX
13534	2005	Oil	30"	BP Pipelines (North America)	LA
13534	2005	Oil	30"	Mardi Gras Endymion Oil Pipeline Co.	LA
17108	2007	Gas/Condensate	16"	Stone Energy Corporation	LA
17691	2009	Gas/Oil	08"	Stone Energy Corporation	LA

*Year when the initial hydrostatic test occurred.

Source: USDOI, BOEMRE, 2011c.

Table 3-17

Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Platforms, 1964-2010

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Facility or Structure and Cause of Spill
4/08/1964	EI 208	94	48	2,559	Continental Oil	Freighter struck Platform A: fire, platform and freighter damaged
10/03/1964	Hurricane Hilda			11,869[4]	Event Total	5 platforms destroyed during Hurricane Hilda
	EI 208	94	48	5,180	Continental Oil	Platforms A, C, and D destroyed: blowouts (several days)
	SS 149	55	33	5,100	Signal O & G	Platform B destroyed: blowout (17 days)
	SS 199	102	44	1,589	Tenneco Oil	Platform A destroyed: lost storage tank
7/19/1965	SS 29	15	7	1,688[5]	PanAmerican	Well #7 drilling: blowout (8 days), minimal damage
1/28/1969	6B 5165 Santa Barbara Channel, California	190	6	80,000	Union Oil	Well A-21 drilling: blowout (10 days), 50,000 bbl during blowout phase, subsequent seepage of 30,000 bbl (over decades), 4,000 birds killed, considerable oil on beaches, platform destroyed
3/16/1969	SS 72	30	6	2,500	Mobil Oil	Submersible rig *Rimtide* drilling in heavy seas bumped by supply vessel
2/10/1970	MP 41	39	14	65,000[6]	Chevron Oil	Platform C: rig shifted and sheared wellhead, blowout (3-4 days), fire of unknown origin, blowout 12 wells (49 days), lost platform, minor amounts of oil on beaches
12/1/1970	ST 26	60	8	53,000	Shell Oil	Platform B: wireline work, gas explosion, fire, blowout (138 days), lost platform and 2 drilling rigs, 4 fatalities, 36 injuries, minor amounts of oil on beaches
1/09/1973	WD 79	110	17	9,935	Signal O & G	Platform A: oil storage tank structural failure
1/26/1973	PL 23	61	15	7,000	Chevron Oil	Platform CA: storage barge sank in heavy seas
11/23/1979	MP 151	280	10	1,500[7]	Texoma Production	MODU Pacesetter III: diesel tank holed, workboat contact in heavy seas
11/14/1980	HI 206	60	27	1,456	Texaco Oil	Platform A: storage tank overflow during Hurricane Jeanne evacuation
9/24/2005	Hurricane Rita			5,066[8]	Event Total	1 platform and 2 rigs destroyed by Hurricane Rita
	EI 314	230	78	2,000[5]	Forest Oil	Platform J: destroyed, lost oil on board and in riser
	SM 146	238	78	1,494[9]	Hunt Petroleum	Jack-up Rig Rowan Fort Worth: swept away, never found
	SS 250	182	69	1,572[9]	Remington O & G	Jack-up Rig Rowan Odessa: legs collapsed
04/20/2010	MC 252	4,992	53	4.9 million[10]	BP E & P	*Deepwater Horizon* Rig: gas explosion, blowout (86 days to cap well), fire, drilling rig sank, 11 fatalities, multiple injuries, considerable oil on beaches, wildlife affected, temporary closure of area fisheries

Table 3-17. Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Platforms/Rigs, 1964-2010 (continued).

Notes: barrel (bbl) = 42 gallons, billion = 10^9, MODU = mobile offshore drilling unit
Between 1964 and 2009, over 17.5 billion bbl of oil and 176.1 Mcf of natural gas were produced on the OCS.

[1] Crude oil release unless otherwise noted; no spill contacts to land unless otherwise noted.

[2] Outer Continental Shelf (OCS) - submerged lands, subsoil, and seabed administered by the U.S. Federal Government (http://www.boemre.gov/aboutmms/ocsdef.htm).

[3] Gulf of Mexico leasing area unless otherwise noted (official protraction diagrams, http://www.gomr.boemre.gov/homepg/lsesale/map_arc.html): EI = Eugene Island, HI = High Island,
MC = Mississippi Canyon, MP = Main Pass, PL = South Pelto, SS = Ship Shoal, SM = South Marsh Island, ST = South Timbalier, and WD = West Delta.

[4] Hurricane Hilda, 10/3/1964: platform spills ≥1,000 bbl at 3 facilities totaled 11,869 bbl; treated as 1 spill event.

[5] Condensate - a liquid product of natural gas production.

[6] Spill volume estimate between 30,000 and 65,000 bbl, previously reported as 30,000 bbl.

[7] Diesel fuel.

[8] Hurricane Rita, 9/24/2010: platform and 2 rig losses ≥1,000 bbl at 3 locations totaled to 5,066 bbl; treated as 1 spill event. The 5,066-bbl spill was a "passive" spill based on unrecovered pre-storm inventories from the platform and 2 rigs; no spill observed; no response required.

[9] Diesel fuel and other refined petroleum products stored on rig.

[10] The Federal Interagency Solutions Group, 2010.

Source: USDOI, BOEMRE, 2011c.

Table 3-18

Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Pipelines, 1964-2010

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Pipeline Segment (pipeline authority[4]) Cause/Consequences of Spill
10/15/1967	WD 73	168	22	160,638	Humble Pipe Line	12" oil pipeline, Segment #7791 (DOT): anchor kinked, corrosion, leak
3/12/1968	ST 131	160	28	6,000	Gulf Oil	18" oil pipeline, Segment #3573 (DOT): barge anchor damage
2/11/1969	MP 299	210	17	7,532	Chevron Oil	4" gas pipeline, Segment #3469 (DOT): , anchor damage
5/12/1973	WD 73	168	22	5,000	Exxon Pipeline	16" gas & oil pipeline, Segment #807 (DOT): internal corrosion, leak
4/17/1974	EI 317	240	75	19,833	Pennzoil	14" oil Bonita pipeline, Segment #1128 (DOI): anchor damage
9/11/1974	MP 73	141	9	3,500	Shell Oil	8" oil pipeline, Segment #36 (DOI): Hurricane Carmen broke tie-in to 12" pipeline, minor contacts to shoreline, brief cleanup response in Chandeleur Area
12/18/1976	EI 297	210	17	4,000	Placid Oil	10" oil pipeline, Segment #1184 (DOI): trawl damage to tie-in to 14" pipeline
12/11/1981	SP 60	190	4	5,100	Atlantic Richfield	8" oil pipeline, Segment #4715 (DOT): workboat anchor damage
2/07/1988	GA A002	75	34	15,576	Amoco Pipeline	14" oil pipeline, Segment #4879 (DOT): damage from illegally anchored vessel
1/24/1990	SS 281	197	60	14,423[5]	Shell Offshore	4" condensate pipeline, Segment #8324 (DOI): anchor damage to subsea tie-in
5/06/1990	EI 314	230	78	4,569	Exxon	8" oil pipeline, Segment #4030 (DOI): trawl damage
8/31/1992	PL 8	30	6	2,000	Texaco	20" oil pipeline, Segment #4006 (DOT): Hurricane Andrew, loose rig Treasure 75, anchor damage, minor contacts to shoreline, brief cleanup response
11/16/1994	SS 281	197	60	4,5335	Shell Offshore	4" condensate pipeline, Segment #8324 (DOI): trawl damage to subsea tie-in
1/26/1998	EC 334	264	105	1,211[5]	Pennzoil E & P	16" gas & condensate pipeline, Segment #11007 (DOT): anchor damage to tie-in to 30" pipeline, anchor dragged by vessel in man-overboard response
9/29/1998	SP 38	108	6	8,212	Chevron Pipe Line	10" gas & oil pipeline, Segment #5625 (DOT): Hurricane Georges, mudslide damage, small amount of oil contacted shoreline
7/23/1999	SS 241	133	50	3,200	Seashell Pipeline	12" oil pipeline, Segment #6462 & Segment #6463 (DOT): “Loop Davis” jack-up rig, barge crushed pipeline when sat down on it
1/21/2000	SS 332	435	75	2,240	Equilon Pipeline	24" oil pipeline, Segment #10903 (DOT): anchor damage from MODU under tow
9/15/2004	MC 20	479	19	1,720[6]	Taylor Energy	6" oil pipeline, Segment #7296 (DOI): Hurricane Ivan, mudslide damage
9/13/2008	HI A264	150	73	1,316[7]	HI Offshore System	42" gas pipeline, Segment #7364 (DOT): Hurricane Ike, anchor damage parted line
7/25/2009	SS 142	60	30	1,500	Shell Pipe Line	20" oil pipeline, Segment #4006 (DOT): micro-fractures from chronic contacts at pipeline crossing caused failure (separators between pipelines missing)

Table 3-18 Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Pipelines, 1964-2010 (continued)

Notes: barrel (bbl) = 42 gallons, billion = 10^9, MODU = mobile offshore drilling unit.
Between 1964 and 2009, over 17.5 billion bbl of oil and 176.1 Mcf of natural gas were produced on the OCS.

[1] Crude oil release unless otherwise noted; no spill contacts to land unless otherwise noted.

[2] Outer Continental Shelf (OCS) - submerged lands, subsoil, and seabed administered by the U.S. Federal Government (http://www.boem.gov/Oil-and-Gas-Energy-Program/Leasing/Outer-Continental-Shelf/Index.aspx).

[3] Gulf of Mexico leasing area unless otherwise noted (official protraction diagrams, http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/opd2-pdf.aspx): EC = East Cameron, EI = Eugene Island, GA = Galveston, HI = High Island, MC = Mississippi Canyon, MP = Main Pass, PL = South Pelto, SS = Ship Shoal, SP = South Pass, ST = South Timbalier, WD = West Delta.

[4] Pipeline authority: DOI = Department of the Interior, BOEMRE; DOT = Department of Transportation, PHMSA.

[5] Condensate - a liquid product of natural gas production.

[6] The 1,720-bbl spill was a "passive" spill based on unrecovered pre-storm inventory trapped in the segment by a mudslide; no spill observed, no response required.

[7] The 1,316-bbl spill was a "passive" spill based on unrecovered pre-storm inventory in the segment parted by storm; no spill observed, no response required.

Source: USDOI, BOEMRE, 2011c.

Table 3-19

Oil-spill Occurrence Probability Estimates for Offshore Spills Greater Than or Equal to 1,000 barrels Resulting from the WPA and CPA Proposed Actions (2012-2017) and the Gulfwide Program (2012-2051)

	Volume (Bbbl)	Mean Number of Spills			Mean Number of Spills	Probability (% chance) of One or More Spills			Probability (% chance) of One or More Spills
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Proposed Actions									
WPA (low estimate)	0.114	0.03	0.10	0.00	0.13	3	10	n	12
CPA (low estimate)	0.460	0.12	0.40	0.00	0.52	11	33	n	41
WPA (high estimate)	0.119	0.05	0.17	0.00	0.22	5	15	n	20
CPAl (high estimate)	0.894	0.22	0.74	0.02	0.98	20	52	2	62
OCS Program									
WPA (low estimate)	2.510	0.63	2.21	0.00	2.84	47	89	n	94
CPAl (low estimate)	15.831	3.96	13.93	0.00	17.89	98	**	n	**
Gulfwide (low estimate)	18.341	4.59	16.14	0.00	20.73	99	**	n	**
WPA (high estimate)	3.697	0.92	2.77	0.19	3.88	60	94	17	98
CPA (high estimate)	21.734	5.43	18.01	0.43	23.87	**	**	35	**
Gulfwide (high estimate)	25.431	6.36	20.78	0.62	27.75	**	**	46	**

Note: Bbbl = billion barrels; n = less than 0.5%; ** = greater than 99.5%.
"Platforms" refers to facilities used in exploration, development, or production.

Source: Ji et al., in preparation.

Table 3-20

Oil-spill Occurrence Probability Estimates for Offshore Spills Greater Than or Equal to 10,000 barrels Resulting from the WPA and CPA Proposed Actions (2012-2017) and the Gulfwide Program (2012-2051)

	Volume (Bbbl)	Mean Number of Spills			Mean Number of Spills	Probability (% chance) of One or More Spills			Probability (% chance) of One or More Spills
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Proposed Actions									
WPA (low estimate)	0.114	0.01	0.02	0.00	0.04	1	2	n	3
CPA (low estimate)	0.460	0.06	0.08	0.00	0.14	6	8	n	13
WPA (high estimate)	0.119	0.03	0.03	0.00	0.06	3	3	n	6
CPA (high estimate)	0.894	0.12	0.15	0.01	0.27	11	14	1	24
OCS Program									
WPA (low estimate)	2.510	0.33	0.45	0.00	0.78	28	36	n	54
CPA (low estimate)	15.831	2.06	2.85	0.00	4.91	87	94	n	99
Gulfwide (low estimate)	18.341	2.38	3.30	0.00	5.69	91	96	n	**
WPA (high estimate)	3.697	0.48	0.57	0.06	1.11	38	43	6	67
CPA (high estimate)	21.734	2.83	3.68	0.14	6.65	94	97	13	**
Gulfwide (high estimate)	25.431	3.31	4.25	0.20	7.76	96	99	18	**

Note: Bbbl = billion barrels; n = less than 0.5%; ** = greater than 99.5%.
"Platforms" refers to facilities used in exploration, development, or production.

Source: Ji et al., in preparation.

Table 3-21

Probability (percent chance) of a Particular Number of Offshore Spills ≥1,000 bbl Occurring as a Result of Either Facility or Pipeline Operations Related to a WPA Proposed Action

Number of Spills	Facility Spills (%)		Pipeline Spills (%)		Total Spills (%)	
	Low[1]	High	Low	High	Low	High
0	97	95	91	85	88	80
1	3	5	9	14	11	18
2	<0.5	<0.5	<0.5	1	1	2
3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

[1] The columns under each spill category refer to the low and high resource estimates.

Table 3-22

Probability (percent chance) of a Particular Number of Offshore Spills ≥1,000 bbl Occurring as a Result of Either Facility or Pipeline Operations Related to a CPA Proposed Action

Number of Spills	Facility Spills (%)		Pipeline Spills (%)		Total Spills (%)	
	Low[1]	High	Low	High	Low	High
0	89	80	67	48	60	38
1	10	18	27	35	31	37
2	1	2	5	13	8	18
3	<0.5	<0.5	1	3	1	6
4	<0.5	<0.5	<0.5	1	<0.5	1
5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

[1] The columns under each spill category refer to the low and high resource estimates.

Table 3-23

Spill Source, Location, and Characteristics of Maximum Spill for Coastal Waters (a) and Offshore Waters (b)
(data extracted from USDOT, CG records, 1996-2009 (c))

Source	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1000 bbl)	Volume of Maximum Spill from the Source (bbl)	Maximum Spill Amount Source / Product / Year
Western Planning Area (WPA)					
Fixed Platform	347	346	1	1,840	Fixed Platform / Oil:Crude / 2000
Pipeline	16	16	0	5	Offshore Pipeline / Natural Gas Condensate / 1998
MODU	34	34	0	2	MODU / Other Oil / 2008
OSV	41	41	0	48	OSV / Oil:Diesel / 1997
Tank Ship or Barge	38	37	1	43,491	Tank Barge / Oil, Fuel:No. 6 / 2005
Known (d)	165	165	0	405	Designated Waterfront Facility / Oil:Crude / 1998
Unknown (e)	290	290	0	500	Unknown / Oil:Crude / 2006
Total	931	929	2	46,291	
Central Planning Area (CPA)					
Fixed Platform	5,116	5,116	0	889	Fixed Platform / Oil:Crude / 1998
Pipeline	26	26	0	6	Offshore Pipeline / Other Oil / 1998
MODU	288	288	0	175	MODU / Oil:Crude / 2000
OSV	362	362	0	146	OSV / Oil, Misc:Lubricating / 1998
Tank Ship or Barge	44	44	0	940	Tank Ship / Other Oil / 2001
Known (d)	3,039	3,039	0	240	Passenger / Oil:Diesel / 1998
Unknown (e)	4,081	4,078	3	1,632	Unknown / Unknown Material, Oil Like / 2002
Total	12,956	12,953	3	4,028	

Table 3-23. Spill Source, Location, and Characteristics of Maximum Spill for Coastal Waters (a) and Offshore Waters (b) (data extracted from USCG records, 1996-2009 (c)) (continued).

Source	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1,000 bbl)	Volume of Maximum Spill from the Source (bbl)	Maximum Spill Amount Source / Product / Year
Coastal Waters: Texas					
Fixed Platform	32	32	0	35	Fixed Platform / Oil:Crude / 2002
Pipeline	3	3	0	5	Offshore Pipeline / Natural Gas Condensate /1997
MODU	7	7	0	143	MODU / Oil:Diesel /2007
OSV	10	10	0	140	OSV / Oil:Diesel / 2003
Tank Ship or Barge	7	7	0	40	Tank Ship / Oil:Crude / 1999
Known (d)	120	120	0	67	Fishing Boat / Oil:Diesel / 1996
Unknown (e)	71	71	0	6	Unknown / Oil:Diesel /2005
Total	250	250	0	435	
Coastal Waters: Louisiana					
Fixed Platform	738	736	2	1,200	Fixed Platform / Oil:Crude / 2007
Pipeline	40	40	0	745	Onshore Pipeline / Oil:Crude / 1998
MODU	22	22	0	62	MODU / Oil:Diesel / 2003
OSV	63	63	0	29	OSV / Oil:Diesel /1996
Tank Ship or Barge	13	13	0	1	Tank Barge / Oil:Crude / 2000
Known (d)	718	717	1	25,420	Designated Waterfront Facility / Oil:Crude / 2005
Unknown (e)	1,432	1,432	0	65	Unknown / Gasoline:Casinghead / 2004
Total	3,026	3,023	3	27,522	

Table 3-23. Spill Source, Location, and Characteristics of Maximum Spill for Coastal Waters (a) and Offshore Waters (b) (data extracted from USCG records, 1996-2009 (c)) (continued).

Source	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1,000 bbl)	Volume of Maximum Spill from the Source (bbl)	Maximum Spill Amount Source / Product / Year
Coastal Waters: Mississippi					
Fixed Platform	6	6	0	0.02	Fixed Platform / Oil, Misc:Motor / 2000
Pipeline	0	0	0	N/A	NA
MODU	4	4	0	0.12	MODU / Oil:Diesel / 1999
OSV	2	2	0	0.07	OSV / Oil:Diesel / 1998
Tank Ship or Barge	5	5	0	1	Tank Barge / Oil, Fuel:No. 2-D
Known (d)	375	375	0	24	Fishing Boat / Oil, Fuel: No. 2-D / 2004
Unknown (e)	40	40	0	2	Unknown / Gasoline: Automotive (Unleaded) / 2002
Total	432	432	0	27	
Coastal Waters: Alabama					
Fixed Platform	19	19	0	0.10	Fixed Platform / Other Oil /1999
Pipeline	0	0	0	N/A	NA
MODU	0	0	0	N/A	NA
OSV	3	3	0	0.02	OSV / Oil, Misc:Lubricating / 2008
Tank Ship or Barge	1	1	0	0.02	Tank Barge / Oil, Misc:Motor / 1996
Known (d)	7	7	0	1	Unknown / Oil, Misc:Lubricating / 2004
Unknown (e)	95	95	0	24	Fishing Boat / Oil:Diesel / 2001
Total	125	125	0	25	

Table 3-23. Spill Source, Location, and Characteristics of Maximum Spill for Coastal Waters (a) and Offshore Waters (b) (data extracted from USCG records, 1996-2009 (c)) (continued).

NA = not applicable.

MODU = mobile offshore drilling unit.

OSV = offshore support vessel.

Note: Reader should note that the spills are reported to the USCG by responsible parties, other private patties, and government personnel. The USCG does not verify the source or volume of every report.

(a) Coastal waters – 0-3 nmi (0-3.5 mi; 0-5.6 km) from the coastline and spills in rivers, lakes, bays, and estuaries.

(b) Western and Central Planning Areas – Spills that occurred in water depths 3 nmi (3.5 mi; 5.6 km) from the coastline to the OCS planning area boundary.

(c) Dickey, official communication, 2011.

(d) Includes sources assumed to not be related to Federal or State oil and gas exploration and production, such as aircraft, deepwater port, commercial vessel, designated waterfront facility, facility particular hazard, factory, fishing boat, freight barge, freight ship, industrial facility, industrial vessel, land facility (nonmarine), land vehicle, unknown, marine, MARPOL reception, unclassified tow/tug, tank truck, oil recovery, municipal facility, onshore pipeline, other onshore marine facility, passenger, public vessel unclassified, recreational, research vessel, railroad equipment, shipyard/repair facility, and shoreline.

(e) Spill sources reported as unknown.

Table 3-24

Primary Cleanup Options Used during the *Deepwater Horizon* Response

	Fresh Oil	Sheens	Mousse	Tarballs	Burn Residue
On-Water Response	Disperse, skim, burn	Light sheens very difficult to recover, heavier sheens picked up with sorbent boom or sorbent pads	Skim	Snare boom	Manual removal
On-Land Response	Sorbent pads, manual recovery, flushing with water, possible use of chemical shoreline cleaning agents	Light sheens very difficult to recover, heavier sheens picked up with sorbent boom or sorbent pads	Sorbent pads, manual recovery	Snare boom, manual removal, beach cleaning machinery	Manual removal

Source: USDOC, NOAA, 2010a.

Table 3-25

Pipelines* Damaged after the 2004-2008 Hurricanes Passed through the WPA and CPA

Hurricane	Total Damage Reports	Pipe and Movement	Platform Connection	Riser	Mudflow	Outside Impact	Unknown
Ivan	168	38	20	67	16	9	18
Katrina	299	61	139	66	1	9	14
Rita	243	31	94	89	0	8	21
Gustav/Ike	314	14	2	273	2	7	16

* Not discriminated by diameter.
Sources: Energo Engineering, 2010; Atkins et al., 2007.

Table 3-26

Causes of Hurricane-Related Pipeline Spills Greater Than 50 Barrels

Hurricane	Amount Spilled (bbl)	Cause
Ivan	1,720	Mudflow
Ivan	671	Movement
Ivan	126	Platform
Ivan	200	Platform
Ivan	250	Platform
Ivan	260	Platform
Ivan	95	Movement
Ivan	123	Movement
Katrina	960	Movement
Katrina	50	Platform
Katrina	55	Riser
Katrina	132	Mudslide
Katrina	50	Movement
Rita	75	Riser
Rita	100	Outside Force
Rita	862	Outside Force/Platform
Rita	67	Platform
Rita	108	Riser
Ike	69	Movement
Ike	108	Riser
Ike	56	Platform
Ike	1,316	Outside Force
Ike	209	Riser
Ike	268	Riser

Source: USDOI, BOEMRE, 2011c.

Table 3-27

Number and Volume of Chemical and Synthetic-Based Fluid Spills
in the Gulf of Mexico during 2001-2009

Spill Size (bbl)	2002		2003		2004		2005	
	Chemical	SBF	Chemical	SBF	Chemical	SBF	Chemical	SBF
50-<100	0	3	1	2	1	1	0	0
100-<500	2	3	1	3	2	2	2	5
500-<1,000	0	0	0	1	0	1	1	0
≥1,000	0	1	0	1	1	1	0	0
Spill Size (bbl)	2006		2007		2008		2009	
	Chemical	SBF	Chemical	SBF	Chemical	SBF	Chemical	SBF
50-<100	1	1	0	0	5	0	0	1
100-<500	1	4	0	1	4	1	2	3
500-<1,000	0	0	1	0	3	0	0	0
≥1,000	0	0	0	1	0	1	0	0

SBF = synthetic-based fluid.
Note: For the years 2002 and 2003, the total volume of drilling fluid was recorded. For 2004 and beyond, the SBF fraction of the whole drilling fluid was recorded.

Table 3-28

Total Offshore Oil and Gas Production in the Offshore Areas
of 12 Contiguous Texas Coastal Counties in 2009

County	Texas State District No.	Total Oil Produced (bbl)	Total Gas Produced (MMcf)
Calhoun	2	116,934	0
Chambers	3	6,166	10,035
Galveston	3	0	0
Brazoria	3	0	0
Matagorda	3	0	0
Jefferson	3	86,078	35,936
Aransas	4	0	0
Nueces	4	20,806	39,967
Kleberg	4	0	0
Kenedy	4	0	0
Willacy	4	0	0
Cameron	4	0	0

bbl = barrel; 42 U.S. gallons
MMcf = 1,000,000 ft^3

Source: Railroad Commission of Texas, 2010.

Table 3-29

Total Producing Wells, Total Oil, and Total Gas Production
in the Nine Coastal Parishes of Louisiana in 2009

Parish	Total Producing Wells	Total Oil Produced (bbl)	Total Gas Produced (Mcf)
St. Bernard	114	666,757	12,662,442
Plaquemines	1,734	16,870,508	74,737,520
Jefferson	221	1,202,961	11,199,616
Lafourche	539	5,769,795	35,366,426
Terrebonne	569	5,984,437	93,070,163
St. Mary	345	3,400,486	40,127,959
Iberia	172	2,891,805	48,567,357
Vermilion	249	3,062,983	63,928,992
Cameron	323	3,278,189	57,276,938
Total	4,266	43,127,921	436,940,000

bbl = barrel; 42 U.S. gallons
Mcf = 1,000 ft^3

Source: Louisiana Dept. of Natural Resources, 2010.

Table 3-30

Designated Ocean Dredged-Material Disposal Sites in the Cumulative Impact Area

ODMDS Name	Location Coordinates		Water Depth	Size	Authorized Material, Last Time Used, and Amount Disposed
	Latitude	Longitude			
Pensacola Nearshore	30°17'24"N	87°18'30"W	~36 ft, ~11 m	2.48 mi^2, 642 ha, 1,587 ac	Medium-grained sand, <10% fines. 1987; 157,100 yd^3
	30°17'00"N	87°19'50"W			
	30°15'36"N	87°17'48"W			
	30°15'15"N	87°19'18"W			
Pensacola Offshore	30°08'50"N	87°19'30"W	65-80 ft 20-24 m	6 mi^2, 1,554 ha, 3,840 ac	Primarily fine-grained. 2005; 63,000 yd^3
	30°08'50"N	87°16'30"W			
	30°07'05"N	87°16'30"W			
	30°07'05"N	87°19'30"W			
Mobile	30°10'00"N	88°07'42"W	~46 ft, ~14 m	4.8 mi^2, 1,243 ha, 3,072 ac	Dredged material meeting USEPA Ocean Dumping Criteria. 2008; 2,235,993 yd^3
	30°10'24"N	88°05'12"W			
	30°09'24"N	88°04'42"W			
	30°08'30"N	88°05'12"W			
	30°08'30"N	88°08'12"W			
Pascagoula	30°12'06"N	88°44'30"W	38-52 ft, 11.5-19 m	18.5 mi^2, 4,791 ha, 11,840ac	Suitable material from the Mississippi Sound and vicinity. 2008; 1,489,100 yd^3
	30°11'42"N	88°33'24"W			
	30°08'30"N	88°37'00"W			
	30°08'18"N	88°41'54"W			
Gulfport West	30°12'00"N	89°00'30"W	~27 ft, ~8.2 m	5.2 mi^2, 1,346 ha, 3,328 ac	Dredged material meeting USEPA Ocean Dumping Criteria. 2005; 390,000 yd^3
	30°12'00"N	88°59'30"W			
	30°11'00"N	89°00'00"W			
	30°07'00"N	88°56'30"W			
	30°06'36"N	88°57'00"W			
	30°10'30"N	89°00'36"W			
Gulfport East	30°11'10"N	88°58'24"W	~30 ft, ~9.1 m	2.47 mi^2, 640 ha, 1,581 ac	Meet USEPA Ocean Dumping Criteria. 1996; 323,300 yd^3
	30°11'12"N	88°57'30"W			
	30°07'36"N	88°54'24"W			
	30°07'24"N	88°54'48"W			
Mississippi River Gulf Outlet	29°22'00"N	88°56'30"W	20-40 ft, 6-12 m	6.03 mi^2, 1,562 ha, 3,859 ac	Dredged material from the vicinity of Mississippi River Gulf Outlet. 2005; 909,100 yd^3
	29°23'00"N	88°54'30"W			
	29°24'30"N	88°52'30"W			
Mississippi River - Southwest Pass	28°53'58"N	89°25'31"W	8-106 ft, 2.7-32.2 m	3.44 mi^2, 891 ha, 2,202 ac	Dredged material from the vicinity of the Southwest Pass Channel. 2008; 6,890,400 yd^3
	28°53'45"N	89°25'09"W			
	28°53'13"N	89°25'28"W			
	28°53'11"N	89°24'49"W			
Barataria Bay Waterway	29°13'30"N	89°53'30"W	8-20 ft, 2.4-6.1 m	1,4 mi^2, 362 ha, 896 ac	Dredged material from the vicinity of Barataria Bay Waterway. 1988; 775,000 yd^3
	29°13'54"N	89°53'48"W			
	29°14'21"N	89°54'06"W			
Houma Navigation Canal (Cat Island Pass)	28°58'09"N	90°29'30"W	6-30 ft, 1.8-9.1 m	2.08 mi^2, 539 ha, 1,331 ac	Dredged material from the vicinity of Cat Island Pass, Louisiana. 1997; 117,400 yd^3
	28°58'57"N	90°31'30"W			
	28°57'57"N	90°31'54"W			

Table 3-30. Designated Ocean Dredged-Material Disposal Sites in the Cumulative Impact Area (continued).

ODMDS Name	Location Coordinates		Water Depth	Size	Authorized Material, Last Time Used, and Amount Disposed
	Latitude	Longitude			
Atchafalaya Bar Channel	29°07'00"N 29°08'00"N 29°09'00"N	91°31'30"W 91°29'00"W 91°27'00"W	~16 ft, ~4.8 m	9.14 mi^2, 2,367 ha, 5,850 ac	Dredged material from the bar channel of the Atchafalaya River. 2008; 9,545,800 yd^3
Calcasieu River and Pass	29°30'00"N 29°30'51"N 29°30'00"N	93°10'18"W 93°10'00"W 93°09'27"W	36-46 ft, 11 to 14 m	5.8 mi^2, 1,502 ha, 3,712 ac	Dredged material from the vicinity of the Calcasieu River and Pass Project. 2008; 364,700 yd^3
Sabine-Neches Waterway Nos. 1 and 2	29°27'30"N 29°27'30"N 29°26'38"N 29°26'38"N	93°37'00"W 93°36'45"W 93°36'45"W 93°37'00"W	25.7-42.6 ft, 9-13 m	6.6 mi^2, 1709 ha, 4,224 ac	Dredged material from the Sabine-Neches area. 2006; 1,524,200 yd^3
Sabine-Neches Waterway Nos. 3 and 4	29°35'52"N 29°35'52"N 29°35'00"N 29°35'00"N	93°41'45"W 93°41'30"W 93°41'30"W 93°41'45"W	16.4-33 ft, 5-10 m	8.9 mi^2, 2,305 ha, 5,696 ac	Dredged material from the Sabine-Neches area. 2008; 1,691,900 yd^3
Galveston Harbor and Channel	29°20'22"N 29°19'32"N 29°19'23"N 29°20'13"N	94°37'11"W 94°36'56"W 94°37'06"W 94°37'21"W	33-51 ft, 10-15.5 m	6.6 mi^2, 1,709 ha, 4,224 ac	Dredged material from the Galveston, Texas, area. 2008; 2,395,800 yd^3
Freeport Harbor, New Work	28°54'28"N 28°54'35"N 28°55'07"N 28°54'60"N	95°13'40"W 95°13'28"W 95°14'01"W 95°14'13"W	54-61 ft, 16.4-18.6 m	2.64 mi^2, 684 ha, 1,690 ac	Dredged material from the Freeport Harbor Entrance and Jetty Channels, Texas. 1992; 46,800 yd^3
Matagorda Ship Channel	28°24'27"N 28°24'33"N 28°25'10"N 28°25'04"N	96°16'04"W 96°15'52"W 96°16'30"W 96°16'42"W	25-40 ft, 7.5-12.2 m	0.56 mi^2, 145 ha, 358 ac	Dredged material from the Matagorda Ship Channel, Texas. 2006; 336,700 yd^3
Corpus Christi Ship Channel	27°50'10"N 27°50'20"N 27°50'48"N 27°50'38"N	96°59'17"W 96°59'09"W 96°59'57"W 97°00'05"W	35-50 ft, 10.6-15.2m	0.63 mi^2, 163 ha, 403 ac	Dredged material from the Corpus Christi Ship Channel, Texas. 2007; 954,600 yd^3
Port Mansfield	26°32'11"N 26°31'58"N 26°31'58"N 26°32'11"N	97°13'44"W 97°13'44"W 97°14'42"W 97°14'42"W	35-50 ft, 10.6-15.2 m	0.42 mi^2, 109 ha, 269 ac	Dredged material from the Port Mansfield Entrance Channel, Texas. 1986; 104,200 yd^3
Brazos Island Harbor	26°02'18"N 26°02'18"N 26°02'05"N 26°02'05"N	96°06'30"W 97°07'26"W 97°07'26"W 96°06'30"W	55-65 ft, 16.7-19.8 m	0.42 mi^2, 109 ha, 269 ac	Dredged material from the Brazos Island Harbor Entrance Channel, Texas. 1997; 350,900

~ approximately.

Sources: National Archives and Records Administration, 2010; U.S. Dept. of the Army, COE, 2011.

Table 3-31

Quantities of Dredged Materials Disposed of
in Ocean Dredged-Material Disposal Sites between 2000 and 2009

Galveston District		
Year	Amount Disposed of in ODMDS	
	yd^3	m^3
2000	9,414,000	7,197,944
2001	6,828,400	5,220,995
2002	4,874,300	3,726,890
2003	8,221,300	6,286,006
2004	4,078,900	3,118,727
2005	1,250,900	956,438
2006	9,182,200	7,020,710
2007	6,361,200	4,863,774
2008	5,664,800	4,331,306
2009	7,618,900	5,825,411
Average per year	6,349,490	4,854,820
New Orleans District		
Year	Amount Disposed of in ODMDS	
	yd^3	m^3
2000	16,377,800	12,522,466
2001	23,272,300	17,794,001
2002	57,643,200	44,073,991
2003	22,546,200	17,238,825
2004	21,156,300	16,176,107
2005	21,403,200	16,364,887
2006	13,493,400	10,317,054
2007	17,550,700	13,419,265
2008	16,800,900	12,845,968
2009	16,295,000	12,459,157
Average per year	22,653,900	17,321,172

ODMDS = ocean dredged-material disposal sites.

Source: U.S. Dept. of the Army, COE, 2011.

Table 3-32

Projected OCS Sand Borrowing Needs for Planned Restoration Projects

Restoration Project	Maximum Sand (yd^3)	OCS Lease Area and Block Number (if known)
Pelican Island (CWPPRA BA-35)	~5,500,000	West Delta (Sandy Point site)
Raccoon Island (CWPPRA TE-48)	750,000-830,000	Ship Shoal 64 and 71
Cameron Parish Shoreline	~10,000,000	Sabine Bank
Point Au Fer Shoreline, Terrebonne Basin	N/A	NA
Raccoon Island	~8,340,000	Ship Shoal 88 and 89; South Pelto 12 and 13
Whiskey Island	~7,720,000	Ship Shoal 88 and 89; South Pelto 12 and 13
Trinity and East Islands	~16,260,000	Ship Shoal 88 and 89; South Pelto 12 and 13
Timbalier Island	~10,700,000	Ship Shoal 88 and 89; South Pelto 12 and 13
East Timbalier Island, Barataria Basin	~11,230,000	NA
Caminada Headland	~6,000,000	South Pelto 12 and 13
Total	~76,500,000	

NA = not available
~ approximately

Table 3-33

Vessel Calls at U.S. Gulf Coast Ports in 2004 and 2009

Vessel Type	2004 Percent of Total Calls in U.S.	2009 Percent of Total Calls in U.S.
Tanker	52.4	55.8
Container	7.0	9.0
Dry Bulk	42.6	46.8
RO-RO (Roll-on Roll-off)	7.0	9.9
Gas	59.8	62.6
Combo	56.2	75.6
General	28.8	39.0
All Types	31.2	34.1

Source: USDOT, MARAD, 2009.

Table 3-34

Corps of Engineers' Galveston District Maintenance Dredging Activity
for Federal Navigation Channels in Texas, 2000-2008*

Harbor, Channel, or Waterway	Year	Volume Dredged	
		yd^3	m^3
Houston-Galveston Ship Channel	2000	1,860,000	1,422,072
Sabine-Neches Waterway	2001	3,107,000	2,375,472
Freeport Harbor and Channel	2001	1,895,000	1,448,831
Matagorda Ship Channel	2001	218,400	166,979
Freeport Harbor and Channel	2002	1,526,400	1,167,017
Sabine-Neches Waterway	2002	2,200,400	1,682,327
Corpus Christi Ship Channel	2003	711,600	544,057
Sabine-Neches Waterway	2003	2,710,500	2,072,326
Freeport Harbor	2003	1,261,600	964,562
Galveston Harbor and Channel	2003	1,602,300	1,225,046
Freeport Harbor	2004	1,417,600	1,083,833
Matagorda Ship Channel	2004	279,200	213,464
Sabine-Neches Waterway	2004	1,421,900	1,087,121
Sabine-Neches Waterway	2005	812,500	621,201
Freeport Harbor	2005	143,900	110,019
Sabine-Neches Waterway	2006	1,165,000	890,706
Freeport Harbor	2006	2,620,300	2,003,363
Galveston Harbor and Channel	2006	2,863,000	2,188,921
Matagorda Ship Channel	2006	257,400	196,796
Corpus Christi Ship Channel	2006	114,500	87,541
Freeport Harbor	2007	1,856,200	1,419,167
Galveston Harbor	2007	2,247,100	1,718,031
Corpus Christi Ship Channel	2007	729,900	558,049
Sabine-Neches Waterway	2007	30,600	23,395
Sabine-Neches Waterway	2008	1,293,600	989,028
Freeport Harbor	2008	1,205,900	921,977
Galveston Harbor and Channel	2008	1,851,800	1,415,803
Total		37,403,600	28,597,104

* Dredged material disposed of in Ocean Dredged-Material Disposal Site.

Source: U.S. Dept. of the Army, COE, 2011.

Table 3-35

Corps of Engineers' New Orleans District Maintenance Dredging Activity
for Federal Navigation Channels in Louisiana, 2000-2008*

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	2000	10,750,570	8,219,400
Mississippi River, Baton Rouge to Southwest Pass	2000	1,173,886	897,500
Mississippi River Gulf Outlet	2000	1,700,074	1,299,800
Calcasieu River Bar Channel, Cameron Parish	2000	2,754,152	2,105,700
Atchafalaya River Bar Channel, St. Mary Parish Atchafalaya River and Bayous Chene, Boeuf, and Black, LA	2001	14,371,890	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	7,211,517	5,513,600
Atchafalaya River Bar Channel, St. Mary Parish Atchafalaya River and Bayous Chene, Boeuf, and Black, LA	2002	15,273,070	11,677,100
Mississippi River, Baton Rouge to Southwest Pass	2002	15,758,320	12,048,100
Mississippi River Gulf Outlet Bar Channel	2002	2,907,313	2,222,800
Calcasieu River Bar Channel, Cameron Parish	2002	9,335,759	7,137,700
Mississippi River Gulf Outlet	2003	2,265,370	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	11,700,930	8,946,000
Mississippi River Southwest Pass	2003	6,877,597	5,258,300
Mississippi River Gulf Outlet	2004	3,810,583	2,913,400
Atchafalaya River Bar Channel	2004	10,818,710	8,271,500
Calcasieu River and Pass Bar Channel, Cameron Parish	2004	688,766	526,600
Mississippi River Southwest Pass	2004	5,839,476	4,464,600
Mississippi River Gulf Outlet Bar Channel	2005	909,156	695,100
Atchafalaya River Bar Channel	2005	12,811,250	9,794,900
Calcasieu River and Pass Bar Channel	2005	1,683,725	1,287,300
Mississippi River Southwest Pass	2005	6,000,354	4,587,600
Atchafalaya River Bar Channel	2006	8,169,067	6,245,700
Calcasieu River and Pass Bar Channel	2006	1,740,359	1,330,600
Mississippi River Southwest Pass	2006	3,584,831	2,740,800
Mississippi River Southwest Pass	2007	3,004,493	2,297,100
Calcasieu River and Pass Bar Channel	2007	241,840	184,900
Atchafalaya River Bar Channel	2007	14,305,450	10,937,300
Atchafalaya River Bar Channel	2008	9,546,339	7,298,700
Calcasieu River and Pass Bar Channel	2008	364,656	278,800
Mississippi River Southwest Pass	2008	6,890,807	5,268,400
Total		195,884,300	149,764,300

* Dredged material disposed in Ocean Dredged-Material Disposal Site.

Source: U.S. Dept. of the Army, COE, 2011.

Table 3-36

Corps of Engineers' Mobile District Maintenance Dredging Activity
for Federal Navigation Channels in Mississippi, Alabama, and Florida, 2000-2008*

Harbor, Channel, or Waterway	Year	Volume Dredged	
		yd^3	m^3
Mobile Harbor	2000	5,911,675	4,519,800
Pascagoula Harbor and Bayou Casotte Extension	2000	7,651,642	5,850,100
Mobile Harbor	2001	4,594,177	3,512,500
Pascagoula Harbor	2001	3,200,032	2,446,600
Pascagoula Harbor and Bayou Casotte Extension	2001	294,812	225,400
Mobile Harbor	2002	4,101,602	3,135,900
Gulfport Harbor	2002	943,032	721,000
Pascagoula Harbor	2002	630,301	481,900
Mobile River	2003	2,067,608	1,580,800
Mobile Harbor	2003	1,723,356	1,317,600
Mobile Bay Channel	2003	2,741,726	2,096,200
Mobile Bay	2003	253,350	193,700
Gulfport Bar	2003	128,310	98,100
Pascagoula Bar	2003	123,339	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	120,854	92,400
Mobile Harbor	2004	7,849,273	6,001,200
Pascagoula Harbor	2004	1,203,576	920,200
Gulfport Harbor	2004	849,514	649,500
Mobile Harbor	2005	3,224,098	2,465,000
Pascagoula Bar	2005	120,069	91,800
Gulfport Bar	2005	390,031	298,200
Pensacola Harbor	2005	63,043	48,200
Mobile Harbor	2006	2,546,711	1,947,100
Pascagoula Harbor	2006	672,548	514,200
Mobile Harbor	2007	1,952,901	1,493,100
Mobile Harbor Federal Navigation Project	2008	3,725,305	2,848,200
Total		58,479,130	44,710,500

* Dredged material disposed in Ocean Dredged-Material Disposal Site.

Source: U.S. Dept. of the Army, COE, 2011.

Table 3-37

Designated Louisiana Service Bases Identified in Applications for Pipelines, Exploration, and Development Plans between 2003 and 2008 and Miles of Navigation Canal Bordered by Saltwater, Brackish Water, and Freshwater Wetlands

Shore Base	Number of Pipeline Applications with Designated Service Base		Number of Exploration and Development Plans with Designated Service Base		Miles Bordering Salt and Brackish Wetlands	Miles Bordering Fresh Wetlands
	2003-2008	Percent	2003-2008	Percent		
Fourchon	303	31.5	618	44.4	0**	0**
Cameron	247	25.7	383	27.5	0	0
Intracoastal City	102	10.6	94	6.7	6.4	0
Venice	96	10.0	139	9.9	Miss. River	0
Morgan City	68	7.1	52	3.7	Miss. River	0
Leeville	37	3.9	18	1.3	0	0
Grand Isle	29	3.0	2	0.1	0	0
Dulac	20	2.1	8	0.6	1.7	0
Berwick	14	1.5	19	1.4	Miss. River	0
Lake Charles	12	1.2	1	0.1	3.4	0
Freshwater City	10	1.0	18	1.3	0	0
Houma	8	0.8	18	1.3	5.3	6.6
Amelia	2	0.2	7	0.5	0	0
Galliano	1	0.1	7	0.5	0	0
Boothville	3	0.3	6	0.4	Miss. River	0
Abbeville	7	0.7	0	0.0	0	0
Grand Chenier	2	0.2	1	0.1	0	0
Grand Total	961	99.9	1,391	99.8	16.8	6.6

* Compiled by BOEM staff using operator-designated service bases from OCS plans and pipeline applications.
** "0" indicates that the service base has no surrounding wetlands in the category.

Table 3-38

Hurricane Landfalls in the Northern Gulf of Mexico from 1995 through 2010

Event	Year	Affected State	Storm Name	Intensity at Landfall
1	1995	AL, FL	Opal	Hurricane Category 3
2	1995	FL	Erin	Hurricane Category 2
3	1997	LA, AL	Danny	Hurricane Category 1
4	1998	FL	Earl	Hurricane Category 1
5	1998	MS, AL	Georges	Hurricane Category 2
6	1999	TX	Bret	Hurricane Category 3
7	2002	LA	Lili	Hurricane Category 1
8	2003	TX	Claudette	Hurricane Category 1
9	2004	MS, AL	Ivan	Hurricane Category 4
10	2005	LA, MS	Cindy	Hurricane Category 1
11	2005	FL, AL	Dennis	Hurricane Category 3
12	2005	LA, MS	Katrina	Hurricane Category 5
13	2005	TX, LA	Rita	Hurricane Category 3
14	2007	TX, LA	Humberto	Hurricane Category 1
15	2008	LA	Gustav	Hurricane Category 2
16	2008	TX, LA	Ike	Hurricane Category 4
17	2008	TX	Dolly	Hurricane Category 1

Note: There were no hurricane landfalls in the northern Gulf of Mexico in 2009 or 2010.

Source: USDOC, NOAA, 2010b.

Table 3-39

Oil Spilled from Pipelines on the Federal OCS, 2002-2009

Regulator	Area	Total Oil Spilled (bbl)	Oil Spilled due to Hurricanes (bbl)	Proportion of Total Oil Spilled due to Hurricanes (%)
BOEM	Federal OCS	5,522	5,179	94
DOT	Federal OCS	5,667	3,272	58
DOT	State Waters	9,903	9,622	97

Source: USDOI, BOEMRE, 2011c.

Table 4-1

National Ambient Air Quality Standards

Pollutant	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide	9 ppm (10 mg/m^3) 35 ppm (40 mg/m^3)	8-hour (1) 1-hour (1)	None	
Lead	0.15 µg/m^3 (2) 1.5 µg/m^3	Rolling 3-Month Average Quarterly Average	Same as Primary Same as Primary	
Nitrogen Dioxide	53 ppb (3) 100 ppb	Annual (Arithmetic Average) 1-hour (4)	Same as Primary None	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour (5)	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3 35 µg/m^3	Annual (6) (Arithmetic Average) 24-hour (7)	Same as Primary Same as Primary	
Ozone	0.075 ppm (2008 std) 0.08 ppm (1997 std) 0.12 ppm	8-hour (8) 8-hour (9) 1-hour (10)	Same as Primary Same as Primary Same as Primary	
Sulfur Dioxide	0.03 ppm 0.14 ppm	Annual (Arithmetic Average) 24-hour (1)	0.5 ppm	3-hour (1)
	75 ppb (11)	1-hour	None	

(1) Not to be exceeded more than once per year.
(2) Final rule signed October 15, 2008.
(3) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(4) To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).
(5) Not to be exceeded more than once per year on average over 3 years.
(6) To attain this standard, the 3-year average of the weighted annual mean $PM^{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m^3.
(7) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).
(8) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).
(9) (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as USEPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(c) The USEPA is in the process of reconsidering these standards (set in March 2008).
(10) (a) The USEPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding").
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤ 1.
(11) (a) Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

Table 4-2

Projected Average Annual OCS Emissions Related to the Proposed Action in the WPA by Source (tons/year)

Source	Low - High Case		Emissions - Highest Annual (tons/year)						
	NO_X	SO_X	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	731-1,237	93-157	13-22	13-22	18-30	180-306	37,899-64,142	1.7-2.8	0.2-0.3
Development/Production Well Drilling	467-725	59-92	8-13	8-13	11-17	114-178	24,252-37,611	1.0-1.5	0.2-0.2
Platform Installation and Removal	94-100	14-14.5	2.5-2.4	2.5-2.4	2.5-2.4	14-13	6,383-5,967	0.1-0.0	0.3-0.3
Pipeline Installation	195-456	33-77	7-17	7-17	7-17	40-95	13,177-30,835	0.1-0.3	0.6-1.3
Production Platforms	797-1,222	19-30	7-11	7-11	509-780	893-1,369	87,902-134,783	2,131-3,267	1.3-2.0
Support Vessels	1,434-2,200	193-296	25-38	25-38	25-38	137-210	78,701-120,674	0.5-0.8	3.7-5.7
Helicopters	12-18.1	2.9-4.5	25-38.1	25-38.1	29-43.8	145-222	14,571-22,342	NA-NA	NA-NA
Tankers Loading	0.0-12	0.0-2	0.0-0.5	0.0-0.5	0.0-87	0.0-3	0.0-830	0.0-0.01	0.0-0.04
Tankers in Transit	0.0-265	0.0-32	0.0-4	0.0-4	0.0-6	0.0-22	0.0-13,085	0.0-0.1	0.0-1
Tankers Unloading	0.0-12	0.0-2	0.0-0.5	0.0-4	0.0-44	0.0-3	0.0-830	0.0-0.01	0.0-0.04
Total	3,944-6,247	443-67.4	92-142	92-142	698-1,016	1,545-2,394	274,231-417,185	2,134-3,273	7-10

NA = not available.

Note: Used 50 years of data including the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010). Most data are from the last 20 years.

Source: Wilson et al., 2010.

Table 4-3

Recommended Mitigation Techniques Used to Avoid or Reduce Adverse Impact to Wetlands by Pipelines, Canals, Dredging, and Dredged Material Placement

Technique	Decision Process	Factors to Consider
	Pipeline Construction	
Avoidance	Route selection and location Evaluation of potential routes that avoid wetlands entirely Shared right-of-way (ROW) and pipelines Using all or part of an existing ROW would avoid new impacts to wetlands	Length of route Difficulty of the land for pipeline installation, i.e., access points and sediment characteristics Presence of other pipelines Presence of transportation corridors Density of surrounding developments Number of different land owners
Minimization	Necessity of pipeline contents	Environment function Timing of the project Previous pipeline installations Availability of equipment
Location/Route Selection	Early planning Considering wetland type Use of aerial photography as well as digital and topographic maps combined with field surveys to identify route of minimal impact	Most routes are predetermined by the beginning and end points Flexibility within general route to locate sections of pipelines to one side or another to take advantage of upland areas, existing ROW, etc.
Existing ROW/Corridors	Plan routes paralleling existing pipelines (safety issues) Timing right to share section of pipeline between or among users	Group pipelines in corridors where impacts are limited to smaller areas of coastal wetlands
Construction/ Installation	Methods depend on environment pipeline is constructed Flotation canals Push-pull method Single versus double ditching techniques Directional drilling *	Choice of method has implications for Type of impact Access impact Impact from specific equipment
	Dredging	
Dredge and Other Material Disposal	Features associated with pipeline canals and navigation channels Avoid levees by spray dredging, levee manipulation/spoil bank removal, and canal backfilling	Navigation channels and some canals must be left open for access Impacts associated with spoil banks include soil compaction, impoundment, and creation of upland vegetation
Dredge Material Bank Removal	Identify areas to place dredge Navigation channels Canals that cannot be backfilled Potential use for filling nearby old canal or abandoned navigation channels Off-site mitigation	Due to expense and difficulty in many coastal areas only used in sensitive areas
Levee Manipulation	Dredge material should allow water to pass through openings in the line of dredge placement	Levees used as walkways and built from material placed in a long line paralleling the length of the project is detrimental to marsh and should be built discontinuous instead Must maintain natural hydrologic pattern Technique is post-construction technique where sections of dredge banks are removed in order to restore hydrologic flow
Spray Dredge	Suggested and used to avoid completely the creation of dredge banks Spray dredging places material over a large area of marsh surface at a depth that avoids destroying vegetation or altering hydrology	Normally dredge is deposited discontinuously and unevenly, enabling the avoidance of sensitive habitats or minimize spoil over small creeks More costly than more traditional use of the bucket dredge; most contractors along the Gulf Coast have not invested in spray dredge technology
	Canals and Channels	
Backfill	Suggested as a way to minimize impacts from canals and to restore impacted habitats Based on OCS permit information, this is the most common required mitigation in recent years In Texas and Louisiana, a typical backfilled pipeline canal results in 75% reduction in direct impacts to the marsh as compared with non-backfilled canals (Baumann and Turner, 1990)	Involves returning soil into the canal so that the elevation is restored as close as possible to pre-construction elevation May occur on-site for canal restoration, as well as off-site as mitigation for other dredging operations Intended benefits of backfilling are reestablishment of marsh vegetation in the canal and on the re-graded spoil bank, and restoration of marsh soils on bottom of the canal

Table 4-3. Recommended Mitigation Techniques Used to Avoid or Reduce Adverse Impact to Wetlands by Pipelines, Canals, Dredging, and Dredged Material Placement (continued).

Technique	Decision Process	Factors to Consider
Canals and Channels (continued)		
Wood Chipping	A new technique unique to forested wetlands Regulatory personnel believe the use of windrows should be avoided Requirement for chipping on-site started approximately 1992/1993	Prior to 1996, trees removed for ROW being pushed to the side created *windrows* with the potential to act as hydrologic barriers Success of wood chipping remains undetermined Problems encountered include equipment not adapted to the function of marshes, equipment is expensive, and process is time-consuming
Erosion Stabilization	Many impacts are from pipeline canals and navigation channels Stabilization of banks is critical Lack of stabilization can result in slumping of canal sides and blockage of natural creeks/drainage streams	Erosion control measures are required through the use of Best Management Practices Requirement is usually erosion control/siltation fences
Revegetation	Often required by permits Extremely valuable to the acceleration of marsh recover over first growing season Most extensive data exist for the revegetation of dunes, but through the use of directional drilling, is not the concern as in past cases	Stabilizes shorelines, shore banks, and areas surrounding stream crossings where erosion is most likely to occur Helps to reduce sedimentation and erosion
Plugs/Dams	Structures have been used frequently in order to mitigate adverse hydrodynamic impacts and accelerated erosion, i.e., dams, weirs, bulkheads, rip-rap, shell/gravel mats, and biodegradable mats	Reduces erosion and provides barriers to saltwater intrusion Plugs maintain elevated marsh water levels Prevent saltwater intrusion into low-salinity marshes Reduces tidal exchange thereby reducing bank erosion
Erosion Control during Project	Construction of pipelines and navigation Channels is governed by the of Best Management Practices and erosion control during the construction phase is a requirement	Natural features of each construction site should be identified for the necessary erosion control
Timing of Project	Seasonal timing of the project can minimize impacts Avoid impacts to endangered species, particularly bird breeding seasons	Expanding restrictions to ensure there will be at least part of one growing season for re-establishment of vegetation before fall/winter has been discussed, but dismissed for economic reasons to industry
Restoration	Can occur either immediately, post construction, or many years after pipeline and navigation canal construction	Backfilling of canals, resulting in levee removal, has been a requirement for most pipeline installation projects There is a benefit to backfilling old canals and navigation channels in order to reduce or reverse the trend of wetland losses in coastal Louisiana Other options include the use of imported material
Compensation	Typically occurs through the creation of new wetland habitat or through a cash payment to the appropriate land management agency Allows for the creation and restoration of lost wetland habitat In Louisiana, the payment of cash for wetlands into a State trust fund is administered by the Louisiana Dept. of Natural Resources and is controversial This fund has been in existence for several years and has a significant accumulation of funds; however, no creation projects have yet to tap into it	In many cases not an option Saline marshes have yet to be successfully created, and finding appropriate locations to create salt marsh is difficult Forested wetlands are also difficult to compensate

* Trenchless, or directional drilling, is the newest and favored technique in sensitive habitats. This technique is considered to be extremely protective of sensitive habitats. At present, directional drilling is required almost without exception for crossing barrier island and shore faces. Impacts are limited to the access and staging sites for the equipment. By using directional drilling, pipeline installation can occur without having to cut through shore facings, minimizing any erosion and surface habitat disturbance.

Table 4-4

Biotic Zones of Topographic Features with Bank Crest and Seafloor Depth in Meters

Feature	Planning Area	Zone	Crest (m)	Seafloor (m)
Shelf Edge Banks				
East Flower Garden	Western	MS-DMP-M-S-AS-T-A-N	16	100-120
West Flower Garden	Western	MS-DMP-M-S-AS-T-A-N	20	110-130
Alderice	Central	AS-T-A-N	55	84-90
Appelbaum	Western	AS-T-A-N	76	100-120
Bouma	Central	AS-T-A-N	60	90-100
Bright	Central	S-AS-T-A-N	37	110
Diaphus	Central	T-A-N	73	110-130
Elvers	Central	AS-T-A-N	60	180
Ewing	Central	AS-T-A-N	56	85-100
Geyer	Central	AS-T-A-N	37	190-210
Jakkula	Central	AS-T-A-N	59	120-140
MacNeil	Western	AS-T-A-N	62	86-94
McGrail	Central	S-AS-T-A-N	45	110-130
Parker	Central	AS-T-A-N	60	100
Rankin	Western	AS-T-A-N	52	110-140
Rezak	Central	AS-T-A-N	60	120
Sackett	Central	AS-T-A-N	67	100
Sidner	Central	AS-T-A-N	55	150
Sweet	Central	AS-T-A-N	75	130-200
Low-Relief Midshelf Banks				
32 Fathom	Western	T-A-N	52	55
Claypile	Western	A-N	40	50
Coffee Lump	Western	T-A-N	62	70
Midshelf Banks				
29 Fathom	Western	T-A-N	52	72
Fishnet	Central	T-A-N	66	78
Sonnier	Central	MS-M-S-AS-T-A-N	17	50
Stetson	Western	MS-M-S-AS-T-A-N	17	52
Low-Relief South Texas Banks				
Big Dunn Bar	Western	T-A-N	61	67
Blackfish Ridge	Western	T-A-N	60	70-74
Mysterious	Western	T-A-N	70	74-86
Small Dunn Bar	Western	T-A-N	63	67
South Texas Banks				
Aransas	Western	T-A-N	57	70-72
Baker	Western	T-A-N	56	70-74
Dream	Western	T-A-N	62	80
Hospital	Western	T-A-N	59	70-78
North Hospital	Western	T-A-N	58	68-70
South Baker	Western	T-A-N	59	80-84
Southern	Western	T-A-N	58	80

A = Antipatharian Zone
AS = Algal/Sponge Zone
DMP = *Diploria/Montastraea/Porites* Zone
M = *Madracis* Zone
MS = *Millepora*/Sponge Zone
N = Nepheloid Zone
S = *Stephanocoenia*
T = Transitional

Sources: Rezak and Bright, 1981; Rezak et al., 1983.

Table 4-5

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
487 cetaceans stranded*	After the initial response phase ended	November 3, 2010-April 15, 2012**

Note: Numbers are preliminary and may be subject to change. As of April 18, 2012, the unusual mortality event involves 723 cetacean "strandings" in the northern Gulf of Mexico (USDOC, NMFS, 2012).

* 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 then closed again on May 25, 2011.

Table 4-6

Sea Turtles Occurring in the Northern Gulf of Mexico

Order Testudines	ESA Status	ESA-Designated Critical Habitat within the Gulf of Mexico	States with Gulf of Mexico Nesting Reported[1]	Approximate Nesting Time	Relative Occurrence
Family Cheloniidae					
Loggerhead turtle (*Caretta caretta*)	T	None	TX, LA, MS, AL, FL	May-August	C
Green turtle (*Chelonia mydas*)	E/T	None	TX, FL	June-September	C
Hawksbill turtle (*Eretmochelys imbricata*)	E	None	FL	April-November	R
Kemp's ridley turtle (*Lepidochelys kempii*)	E	Pending	TX, AL, FL	April-June	C
Family Dermochelyidae					
Leatherback turtle (*Dermochelys coriacea*)	E	None	TX, FL	March-July	U

Endangered Species Act (ESA) status is summarized according to listing status under the following categories:

Endangered (E): Species determined to be in imminent danger of extinction throughout all of a significant portion of their range.

Threatened (T): Species determined likely to become endangered within the foreseeable future.

Population status in the northern Gulf is summarized according to the following categories:

Common (C): A common species is one that is abundant wherever it occurs in the region (i.e., the northern Gulf). Most common species are widely distributed over the area.

Uncommon (U): An uncommon species may or may not be widely distributed but does not occur in large numbers. Uncommon species are not necessarily rare or endangered.

Rare (R): A rare species is one that is present in such small numbers throughout the region that it is seldom seen. Although not threatened with extinction, a rare species may become endangered if conditions in its environment change.

[1] Dow et al., 2007.

Table 4-7

Some Anthropogenic Sources of Avian Mortality

Source of Mortality	Estimated Mortality (annual)	Reference
Vehicles	60-80 million	Erickson et al., 2001
Buildings and/or Windows	98-980 million	Erickson et al., 2001; Klem, 2009
Power Lines	thousands-174 million	Erickson et al., 2001; Manville, 2005a and 2009
Communication Towers	4-50 million	Erickson et al., 2001; Manville, 2005a and 2009
Mortality by Housecats	~1 billion*	Coleman et al., 1997; Lepczyk et al., 2003
Mortality Associated with Open-Pit Oil Ponds	500,000-1,000,000	Trail, 2006
Mortality Associate with Wind-Farms	10,000-40,000	Erickson et al., 2001; Manville, 2005a and 2009
Mortality Associated with Offshore Oil Platforms	200,000-321,000**	Russell, 2005
Mortality Associated with Commercial Fishing	high thousands-low millions	Manville, 2005b; Brothers et al., 2010
Mortality Associated with Lead (Pb) Ingestion	millions***	Scheuhammer and Norris, 1995; Kendall et al., 1996

* Dauphiné and Cooper (2009) provide estimates ranging from 117 to 157 million outdoor housecats in the United States alone. Further, estimates of annual bird kills/cat from a low of 4 bird kills/cat/year to 54 bird kills/cat/year represents a range of avian mortality of 468 million to ~8.4 billion. Considered the single largest anthropogenic source of avian mortality, likely exceeding collision-related mortality associated with buildings and windows (Dauphiné and Cooper, 2011).

** Estimated from Chapter 17 in Russell (2005) – An estimated 200,000 avian mortalities/year due to collisions only over the entire archipelago; composed primarily of neotropical migrants. Refer to Tables 17.1-17.5 in Russell (2005) for additional information regarding cause of death. The lower estimate generated by taking 200,000 mortalities/year x the lifespan of an offshore platform (38 year) = 7.6 million birds potentially killed on offshore oil platforms over the entire Gulf of Mexico archipelago over the 38-year lifespan of the platforms. The upper estimate reflects the ∑ of spring + fall mortalities (all sources including collision) = 1,411 x a correction factor representing the fraction of all platforms sampled (3403/5 = 680.6) x a correction factor representing the fraction of the potential lifespan of an oil platform sampled (38/3 = 12.67). So, 1,411 x 680.6 x 12.67 = 12.2 million birds potentially killed on offshore oil platforms over the entire Gulf of Mexico archipelago over the 38-year lifespan of the platforms. Note: Russell (2005, page 304) stated, “Based on the seasons with heaviest observed collision mortality (spring 1998, fall 1999), an average Gulf platform may cause 50 deaths (only) by collision per year, suggesting that the platform archipelago may cause roughly 200,000 deaths per year. This number may be biased low because some birds that collide with platforms undoubtedly fall into the sea and avoid detection.” In addition, Russell (2005, page 304) further states “. . . is that future development of the eastern Gulf of Mexico may result in a disproportionately large increase in collision mortality in neotropical migrants.” The estimates in the table only includes data from offshore oil platforms in the Gulf of Mexico and does not consider additional annual avian mortality associated with platforms in the Federal waters of California or Alaska. Therefore, it is likely a gross underestimate of total annual avian mortality associated with offshore oil and gas platforms. This number also does not take into account annual avian mortality associated with chronic oil pollution, operational discharges, routine activities, or other small spills in which no response was initiated (see Piatt et al., 1990a and 1990b; Fraser et al., 2006; Castege et al., 2007; Wiese et al., 2001; Wiese and Robertson, 2004; Wilhelm et al., 2007).

*** No range of estimates was given in references reviewed regarding total annual avian mortality. This unknown, but significant mortality figure has probably declined since the Federal regulations in the U.S. and Canada banning the use of lead shot for hunting migratory birds.

Table 4-8

Birds collected and summarized by the U.S. Fish and Wildlife Service post-*Deepwater Horizon* Event in the Gulf of Mexico[a, b]

				Visibly Oiled			Not Visibly Oiled			Unknown Oiling		Oiling Rate
Common Name	Species Group	Grand Total	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

Table 4-8. Birds collected and summarized by the U.S. Fish and Wildlife Service post-*Deepwater Horizon* event in the Gulf of Mexico[a, b] (continued).

				Visibly Oiled			Not Visibly Oiled			Unknown Oiling		Oiling Rate
Common Name	SpeciesGroup	Grand Total	Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
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
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

Table 4-8. Birds collected and summarized by the U.S. Fish and Wildlife Service post-*Deepwater Horizon* event in the Gulf of Mexico[a, b] (continued).

				Visibly Oiled			Not Visibly Oiled			Unknown Oiling		Oiling Rate
Common Name	SpeciesGroup	Grand Total	Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
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
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

Table 4-8. Birds collected and summarized by the U.S. Fish and Wildlife Service post-*Deepwater Horizon* event in the Gulf of Mexico[a, b] (continued).

				Visibly Oiled			Not Visibly Oiled			Unknown Oiling		Oiling Rate
Common Name	SpeciesGroup	Grand Total	Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
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
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

Table 4-8. Birds collected and summarized by the U.S. Fish and Wildlife Service post-*Deepwater Horizon* event in the Gulf of Mexico[a, b] (continued).

				Visibly Oiled			Not Visibly Oiled			Unknown Oiling		Oiling Rate
Common Name	SpeciesGroup	Grand Total	Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
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
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

Table 4-8. Birds collected and summarized by the U.S. Fish and Wildlife Service post-*Deepwater Horizon* event in the Gulf of Mexico[a, b] (continued).

				Visibly Oiled			Not Visibly Oiled			Unknown Oiling		Oiling Rate
Common Name	SpeciesGroup	Grand Total	Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
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
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	2121		2,642	3,387		3,387	873		1,229	0.24

Table 4-8. Birds collected and summarized by the U.S. Fish and Wildlife Service post-*Deepwater Horizon* event in the Gulf of Mexico[a, b] (continued).

[1] 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; 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., 2010; 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 11,540 birds (59% recovery rate) and an upper range of 14,516 birds (0% recovery rate). These estimates are 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 which are currently unknown. The actual avian mortality estimate will likely not be available until the NRDA process has been completed, which 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. 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).

[2] For additional information on oiling rates by Species Group and additional statistics, see **Table 4-12**.

Table 4-9

Bird Conservation Region 27 (Southeastern Coastal Plain) from Birds of Conservation Concern 2008 List*

(Included are 53 total avian species of which 30 (56.6%) could be considered as potentially impacted by offshore oil and gas development, with 21 (39.6%) representing species with a high probability of oiling in the event of a spill[1,2,3].)

Common Name	Status	Breeding (B) or Nonbreeding (NB)	General Habitat
Red-throated loon	MBTA	NB	Open water: nearshore and offshore
Black-capped petrel	MBTA	NB	Open water: nearshore and offshore
Audubon's shearwater	MBTA	NB	Open water: nearshore and offshore
American bittern	MBTA	NB	Coastal/freshwater marshes, riverine
Least bittern	MBTA	B	Coastal/freshwater marshes, riverine
Roseate spoonbill	MBTA	NB	Coastal and freshwater marshes, riverine
Swallow-tailed kite	MBTA	B	Terrestrial wooded, uplands, coastal marshes
Bald eagle	ESA	B	Terrestrial wooded, uplands, coastal marshes, riverine
American kestrel	MBTA	B	Terrestrial wooded, uplands, riverine
Peregrine falcon	ESA	B	Terrestrial wooded, uplands, coastal marshes, riverine
Yellow rail	MBTA	NB	Coastal marshes
Black rail	MBTA	B	Coastal/freshwater marshes, wetland margins
Limpkin	MBTA	B	Freshwater marshes, riverine
Snowy plover	ESA	B	Beaches, dunes, islands, riverine, wetland margins
Wilson's plover	MBTA	B	Beaches, dunes, islands, wetland margins
American oystercatcher	MBTA	B	Beaches, dunes, islands, wetland margins
Solitary sandpiper	MBTA	NB	Beaches, dunes, islands, wetland margins
Upland sandpiper	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Whimbrel	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Long-billed curlew	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Marbled godwit	MBTA	NB	Beaches, dunes, islands, riverine, wetland margins
Red knot	ESA	NB	Beaches, dunes, islands, wetland margins
Semipalmated sandpiper	MBTA	NB	Beaches, dunes, islands, wetland margins
Buff-breasted sandpiper	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Short-billed dowitcher	MBTA	NB	Coastal marshes, riverine, wetlands
Least tern	ESA	B	Beaches, dunes, islands, riverine, wetland margins
Gull-billed tern	MBTA	B	Beaches, dunes, islands, riverine, wetland margins

Table 4-9. Bird Conservation Region 27 (Southeastern Coastal Plain) from Birds of Conservation Concern 2008 List* (continued).

Common Name	Status	Breeding (B) or Nonbreeding (NB)	General Habitat
Sandwich tern	MBTA	B	Beaches, dunes, islands, riverine, wetland margins
Black Skimmer	MBTA	B	Beaches, dunes, islands, riverine, wetland margins
Common ground-dove	MBTA	B	Terrestrial wooded, uplands
Chuck-will's widow	MBTA	B	Terrestrial wooded, uplands
Whip-poor will	MBTA	B	Terrestrial wooded, uplands
Red-headed woodpecker	MBTA	B	Terrestrial wooded, uplands
Loggerhead shrike	MBTA	B	Terrestrial wooded, uplands
Brown-headed nuthatch	MBTA	B	Terrestrial wooded
Bewick's wren	MBTA	B	Terrestrial wooded
Sedge wren	MBTA	NB	Coastal/freshwater marshes, riverine
Wood thrush	MBTA	B	Terrestrial wooded
Blue-winged warbler	MBTA	B	Terrestrial wooded
Black-throated green warbler	MBTA	B	Terrestrial wooded
Prairie warbler	MBTA	B	Terrestrial wooded, uplands
Cerulean warbler	MBTA	B	Terrestrial wooded
Prothonotary warbler	MBTA	B	Terrestrial wooded
Swainson's warbler	MBTA	B	Terrestrial wooded
Kentucky warbler	MBTA	B	Terrestrial wooded
Bachman's sparrow	MBTA	B	Terrestrial wooded, uplands
Henslow's sparrow	MBTA	B	Uplands
LeConte's sparrow	MBTA	NB	Uplands
Nelson's sharp-tailed sparrow	MBTA	NB	Coastal/freshwater marshes, wetland margins
Saltmarsh sharp-tailed sparrow	MBTA	NB	Coastal marshes, wetland margins
Seaside sparrow	MBTA	B	Coastal/freshwater marshes, wetland margins
Painted bunting	MBTA	B	Terrestrial wooded
Rusty black bird	MBTA	NB	Terrestrial wooded, uplands

Table 4-9. Bird Conservation Region 27 (Southeastern Coastal Plain) from Birds of Conservation Concern 2008 List (continued).

Notes: ESA = Endangered Species Act of 1973.
MBTA = Migratory Bird Treaty Act of 1918.

[*] Information contained in this table, other than the column "General Habitat," was obtained from USDOI, FWS (2008, page 43). Additional information regarding Bird Conservation Region designations can be obtained from the North American Bird Conservation Initiative (2000).

[1] Impacts may be direct or indirect and represent any potential negative impact to breeding, staging, or wintering birds onshore (i.e., beaches, barrier islands, coastal marshes, etc.) or offshore. The probability of oiling is based on FWS avian data from the *Deepwater Horizon* event, King and Sanger (1979), Williams et al. (1995), and Camphuysen (2006), and it is dependent on the species habitat use (e.g., seabirds, shorebirds tend to have higher oiling rates and probabilities compared with marsh birds), and more importantly, the temporal and spatial overlap of a spill given that such an event occurs and overlaps the presence (and abundance) of a given species.

[2] For additional information regarding the impacts of the *Deepwater Horizon* event on various avian species, see **Table 4-8**. Additional information can be obtained from the FWS *Deepwater Horizon* response website (USDOI, FWS, 2010a); for specifics regarding the November 30, 2010, collection report, see USDOI, FWS (2010b). Note: Two additional reports were posted, but they included only an additional 65 birds, which presumably represented identification to species previously as "unknown" and not additional effort to actually collect birds.

[3] Additional information for determining the potential for oiling is based on FWS's websites (USDOI, FWS, 2010c and 2011b). Also see National Audubon Society, Inc. (2010, pages 16-19).

Table 4-10

Bird Conservation Region 31 (Peninsular Florida) from Birds of Conservation Concern 2008 List*

(Included are 49 total avian species of which 30 (61.2%) could be considered as potentially impacted by offshore oil and gas development, with 21 (42.9%) representing species with a high probability of oiling in the event of a spill[1,2,3].)

Common Name	Status	Breeding (B) or Nonbreeding (NB)	General Habitat
Black-capped petrel	MBTA	NB	Open water: nearshore and offshore
Audubon's shearwater	MBTA	NB	Open water: nearshore and offshore
Brown booby	MBTA	NB	Open water: nearshore and offshore
Magnificent frigatebird	MBTA	B	Open water: nearshore and offshore
American bittern	MBTA	NB	Coastal/freshwater marshes, riverine
Least bittern	MBTA	B	Coastal/freshwater marshes, riverine
Reddish egret	MBTA	B	Coastal marshes, mangroves, riverine, wetlands
Roseate spoonbill	MBTA	NB	Coastal/freshwater marshes, riverine
Swallow-tailed kite	MBTA	B	Terrestrial wooded, uplands, coastal marshes
Bald eagle	ESA	B	Terrestrial wooded, uplands, coastal marshes, riverine
Short-tailed hawk	MBTA	B	Terrestrial wooded, uplands
American kestrel	MBTA	B	Terrestrial wooded, uplands, riverine
Peregrine falcon	ESA	B	Terrestrial wooded, uplands, coastal marshes, riverine
Yellow rail	MBTA	NB	Coastal marshes, riverine, wetlands
Black rail	MBTA	B	Coastal/freshwater marshes, wetland margins
Limpkin	MBTA	B	Freshwater marshes, riverine
Snowy plover	ESA	B	Beaches, dunes, islands, riverine, wetland margins
Wilson's plover	MBTA	B	Beaches, dunes, islands, wetland margins
American oystercatcher	MBTA	B	Beaches, dunes, islands, wetland margins
Solitary sandpiper	MBTA	NB	Beaches, dunes, islands, wetland margins
Lesser yellowlegs	MBTA	NB	Beaches, dunes, islands, riverine, wetland margins
Whimbrel	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Long-billed curlew	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Marbled godwit	MBTA	NB	Beaches, dunes, islands, riverine, wetland margins
Red knot	ESA	NB	Beaches, dunes, islands, wetland margins
Semipalmated sandpiper	MBTA	NB	Beaches, dunes, islands, wetland margins
Buff-breasted sandpiper	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Short-billed dowitcher	MBTA	NB	Coastal marshes, riverine, wetlands

Table 4-10. Bird Conservation Region 31 (Peninsular Florida) from Birds of Conservation Concern 2008 List* (continued).

Common Name	Status	Breeding (B) or Nonbreeding (NB)	General Habitat
Least tern	ESA	B	Beaches, dunes, islands, riverine, wetland margins
Black skimmer	MBTA	B	Beaches, dunes, islands, riverine, wetland margins
White-crowned pigeon	MBTA	B	Mangroves, terrestrial wooded, uplands
Common ground-dove	MBTA	B	Terrestrial wooded, uplands
Mangrove cuckoo	MBTA	B	Mangroves, terrestrial wooded, uplands
Smooth-billed ani	MBTA	B	Terrestrial wooded, uplands
Chuck-will's widow	MBTA	B	Terrestrial wooded, uplands
Red-headed woodpecker	MBTA	B	Terrestrial wooded
Loggerhead shrike	MBTA	B	Terrestrial wooded, uplands
Black-whiskered vireo	MBTA	B	Terrestrial wooded, mangroves
Brown-headed nuthatch	MBTA	B	Terrestrial wooded
Yellow warbler	MBTA	B	Terrestrial wooded, uplands
Prairie warbler	MBTA	B	Terrestrial wooded, uplands
Prothonotary warbler	MBTA	B	Terrestrial wooded
Bachman's sparrow	MBTA	B	Terrestrial wooded, uplands
Grasshopper sparrow	MBTA	B	Uplands
Henslow's sparrow	MBTA	NB	Uplands
Nelson's sharp-tailed sparrow	MBTA	NB	Coastal/freshwater marshes, wetland margins
Saltmarsh sharp-tailed sparrow	MBTA	NB	Coastal marshes, wetland margins
Seaside sparrow	ESA	B	Coastal/freshwater marshes, wetland margins
Painted bunting	MBTA	B	Terrestrial wooded

Table 4-10. Bird Conservation Region 31 (Peninsular Florida) from Birds of Conservation Concern 2008 List* (continued).

Notes: ESA = Endangered Species Act of 1973.
MBTA = Migratory Bird Treaty Act of 1918.

* Information contained in this table, other than the column "General Habitat," was obtained from USDOI, FWS (2008, page 47). Additional information regarding Bird Conservation Region designations can be obtained from the North American Bird Conservation Initiative (2000).

[1] Impacts may be direct or indirect and represent any potential negative impact to breeding, staging, or wintering birds onshore (i.e., beaches, barrier islands, coastal marshes, etc.) or offshore. The probability of oiling is based on FWS avian data from the *Deepwater Horizon* event, King and Sanger (1979), Williams et al. (1995), and Camphuysen (2006), and it is dependent on the species habitat use (e.g., seabirds, shorebirds tend to have higher oiling rates and probabilities compared with marsh birds), and more importantly, the temporal and spatial overlap of a spill given that such an event occurs and overlaps the presence (and abundance) of a given species.

[2] For additional information regarding the impacts of the *Deepwater Horizon* event on various avian species, see **Table 4-8**. Additional information can be obtained from the FWS *Deepwater Horizon* response website (USDOI, FWS, 2010a); for specifics regarding the November 30, 2010, collection report, see USDOI, FWS (2010b). Note: Two additional reports were posted, but they included only an additional 65 birds, which presumably represented identification to species previously as "unknown" and not additional effort to actually collect birds.

[3] Additional information to determining potential for oiling is based on FWS's websites (USDOI, FWS, 2010c and 2011b). Also see National Audubon Society, Inc. (2010, pages 16-19).

Table 4-11

Bird Conservation Region 37 (Gulf Coast Prairie) from Birds of Conservation Concern 2008 List*

(Included are 44 total avian species of which 30 (68.2%) could be considered as potentially impacted by offshore oil and gas development, with 20 (45.4%) representing species with a high probability of oiling in the event of a spill[1,2,3].)

Common Name	Status	Breeding (B) or Nonbreeding (NB)	General Habitat
Audubon's shearwater	MBTA	NB	Open water: nearshore and offshore
Band-rumped storm petrel	MBTA	NB	Open water: nearshore and offshore
American bittern	MBTA	NB	Coastal/freshwater marshes, riverine
Reddish egret	MBTA	B	Coastal marshes, mangroves, riverine, wetlands
Swallow-tailed kite	MBTA	B	Terrestrial wooded, uplands, coastal marshes
Bald eagle	ESA	B	Terrestrial wooded, uplands, coastal marshes, riverine
White-tailed hawk	MBTA	B	Uplands
Peregrine falcon	ESA	B	Terrestrial wooded, uplands, coastal marshes, riverine
Yellow rail	MBTA	NB	Coastal marshes, riverine, wetlands
Black rail	MBTA	B	Coastal/freshwater marshes, wetland margins
Snowy plover	ESA	B	Beaches, dunes, islands, riverine, wetland margins
Wilson's plover	MBTA	B	Beaches, dunes, islands, wetland margins
Mountain plover	ESA	NB	Uplands
American oystercatcher	MBTA	B	Beaches, dunes, islands, wetland margins
Solitary sandpiper	MBTA	NB	Beaches, dunes, islands, wetland margins
Lesser yellowlegs	MBTA	NB	Beaches, dunes, islands, riverine, wetland margins
Upland sandpiper	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Whimbrel	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Long-billed curlew	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Hudsonian godwit	MBTA	NB	Coastal/freshwater marshes, beaches, dunes, islands
Marbled godwit	MBTA	NB	Beaches, dunes, islands, riverine, wetland margins
Red knot	ESA	NB	Beaches, dunes, islands, wetland margins
Buff-breasted sandpiper	MBTA	NB	Beaches, dunes, islands, uplands, wetland margins
Short-billed dowitcher	MBTA	NB	Coastal marshes, riverine, wetlands
Least tern	ESA	B	Beaches, dunes, islands, riverine, wetland margins

Table 4-11. Bird Conservation Region 37 (Gulf Coast Prairie) from Birds of Conservation Concern 2008 List* (continued).

Common Name	Status	Breeding (B) or Nonbreeding (NB)	General Habitat
Gull-billed tern	MBTA	B	Beaches, dunes, islands, riverine, wetland margins
Sandwich tern	MBTA	B	Beaches, dunes, islands, riverine, wetland margins
Black Skimmer	MBTA	B	Beaches, dunes, islands, riverine, wetland margins
Short-eared owl	MBTA	NB	Coastal/freshwater marshes, uplands
Loggerhead shrike	MBTA	B	Terrestrial wooded, uplands
Sedge wren	MBTA	NB	Coastal/freshwater marshes, riverine
Sprague’s pipit	ESA	NB	Uplands
Prothonotary warbler	MBTA	B	Terrestrial wooded
Swainson’s warbler	MBTA	B	Terrestrial wooded
Botteri’s sparrow	MBTA	B	Uplands
Grasshopper sparrow	MBTA	B	Uplands
Henslow’s sparrow	MBTA	NB	Uplands
LeConte’s sparrow	MBTA	NB	Uplands
Nelson’s sharp-tailed sparrow	MBTA	NB	Coastal/freshwater marshes, wetland margins
Seaside sparrow	ESA	B	Coastal/freshwater marshes, wetland margins
Painted bunting	MBTA	B	Terrestrial wooded
Dicksissel	MBTA	B	Uplands

Notes: ESA = Endangered Species Act of 1973.
MBTA = Migratory Bird Treaty Act of 1918.

* Information contained in this table, other than the column “General Habitat,” was obtained from USDOI, FWS (2008, page 47). Additional information regarding Bird Conservation Region designations can be obtained from the North American Bird Conservation Initiative (2000).

[1] Impacts may be direct or indirect and represent any potential negative impact to breeding, staging, or wintering birds onshore (i.e., beaches, barrier islands, coastal marshes, etc.) or offshore. The probability of oiling is based on FWS avian data from the *Deepwater Horizon* event, King and Sanger (1979), Williams et al. (1995), and Camphuysen (2006), and it is dependent on the species habitat use (e.g., seabirds, shorebirds tend to have higher oiling rates and probabilities compared with marsh birds), and more importantly, the temporal and spatial overlap of a spill given that such an event occurs and overlaps the presence (and abundance) of a given species.

[2] For additional information regarding the impacts of the *Deepwater Horizon* event on various avian species, see **Table 4-8**. Additional information can be obtained from the FWS *Deepwater Horizon* response website (USDOI, FWS, 2010a); for specifics regarding the November 30, 2010, collection report, see USDOI, FWS (2010b). Note: Two additional reports were posted, but they included only an additional 65 birds, which presumably represented identification to species previously as “unknown” and not additional effort to actually collect birds.

[3] Additional information to determining potential for oiling based on FWS’s websites (USDOI, FWS, 2010c and 2011b). Also see National Audubon Society, Inc. (2010, pages 16-19).

Table 4-12

Relative Oiling Ranks for Various Avian Species Groups Collected Post-*Deepwater Horizon* Event in the Gulf of Mexico[a]

Species Group	Number Representative Spp.[1]	Number Collected	Number Oiled	Oiling Rate (% ± SE)[2]	Oiling Rank[3]
Diving[*]	5	136	65	0.27 ± 0.15	3
Seabirds[*]	26	5,309	2,192	0.34 ± 0.05	1
Shorebirds[*]	12	81	20	0.18 ± 0.09	6
Passerines[*]	21	73	16	0.19 ± 0.07	5
Marsh/Wading[*]	21	378	100	0.26 ± 0.05	4
Waterfowl[*]	12	52	11	0.33 ± 0.12	2
Raptors[*]	7	17	3	0.04 ± 0.04	7

[a] Data obtained from the Fish and Wildlife Service (USDOI, FWS, 2011a) as summarized table dated May 12, 2011. The data used in this table are verified as per the FWS QA/QC processes. *Disclaimer*: All data should be considered provisional, incomplete, and subject to change. For more information see the following link to the FWS Weekly Bird Impact Data and Consolidated Wildlife Reports at http://www.fws.gov/home/dhoilspill/pdfs/Bird%20Data%20Species%20Spreadsheet%2005122011.pdf. Numbers in this table have been verified against the original data from the website.

[*] Species Group: As defined in text in the Multisale EIS. As of May 12, 2011, 7,258 individuals of 104 species had been collected and identified by FWS. Six new species were added and 3 species were dropped since the December 14th Collection Report. Note: The Top 5 most-impacted species are all representatives of the Seabird group, with an oiling rate (0.43) above the combined average of all species including “unknowns” and “other” (0.24). Of the total number of birds collected, only a fraction were oiled (n = 2,642, 36%) compared with unoiled (n = 3,387, 47%) and unknown (n = 1,229, 17%).

[1] Represents the actual number of birds identified to the species level for each of the Species Groups; reflects sample size for determining mean Oiling Rate. This number should be 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 has likely declined dramatically since the *Deepwater Horizon* was plugged/capped.

[2] Oiling Rate: For each species an oiling rate was calculated by dividing the “total” number of oiled individuals (∑ alive + dead) /∑ of individuals collected for a given species within a row. These rates were then used to calculate summary statistics (mean ± SE). Note: Standard errors for Top 3 Species Groups Rank all overlap. In general, it has been well documented that the number of birds collected after a spill event represents an unknown 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; 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; Castege et al., 2007; Byrd et al,. 2010; Flint et al., 2010). For example, Piatt et al. (1996a, 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. 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). For this table, the value obtained for passerines and raptors is almost certainly biased high due to the small sample sizes (several cases where only 1-2 birds/species) for individual species and due to influence of high estimates for oiling (100%). For the other Species Groups, e.g., shorebirds, the value obtained is likely biased low due the larger number of species with several instances where only 1 bird was collected and it did not meet the criteria to be designated as oiled. There was a significant difference (F = 18.42, df = 1, 12; P = 0.001) in oiling rates among Species Groups.

[3] Oiling Rank: Reflects the relative rank of a given Species Group as a function of the mean Oiling Rate. As expected, seabirds, waterfowl, and diving birds had the highest oiling rate of any of the Species Groups (see King and Sanger, 1979; Wiens et al., 1984; Piatt et al., 1990a and 1990b; Williams et al., 1995) due to their reliance on nearshore and offshore habitat (i.e., the water surface and column) for foraging and as a substrate for resting, preening, and other maintenance behaviors.

Table 4-13

Demography and Recovery Potential for the 10 Most Commonly Collected Avian Species Post-*Deepwater Horizon*[a, b]

Species	Age at 1st Breeding	Incubation (days)	Clutch	Nest Success (%)	Hatching Success (%)	Fledging Success (%)	1st-Year S_o (%)	Immature S_o (%)	Adult S_o (%)	Recovery Potential
LAGU	3 years	24 (22-27)	2.5 (2-4)	No data	71.0 (4-82)	41.0 (0-58)	No data	No data	No data	3
BRPE	3-5 years	32 (29-35)	2.95 (2-4)	64.0 (33-100)	67.5 (40-94)	No data	30	No data	No data	6
NOGA	4-6 years	44 (42-46)	1	No data	79.0 (38-89)	90.0 (72-96)	42	>89	>91	10
ROYT	4-6 years	31 (28-35)	1 (1-3)	No data	No data	No data	86	94-95	>95	5
BLSK	2-4 years	24 (21-25)	4 (1-5)	48.0 (0-98)	54.0 (0-85)	No data	No data	No data	No data	2
CLRA	≥1 year	21 (18-28)	7 (2-16)	87.1 (42-94)	No data	43-62	No data	No data	49-67	1
LETE	2-3 years	21 (19-25)	3 (1-4)	63.5 (3-99)	49.5 (3-98)	33.0 (12-68)	No data	80-82	73-95	7
GRSH	>7	51 (47-66)	1 (1-2)	*No data*	56.0	93.0	10-35	≥33	≥90	9
COLO	6 (4-11 years)	28 (26-29)	2 (1-2)	60.0 (33-73)	No data	No data	70 (19-96)	80 (38-97)	91 (64-98)	8
SATE	4 (3-5 years)	24 (21-29)	1.41 (1-2)	No data	78.1 (0-100)	64.3 (6-73)	55 (39-56)	75-84	70.5 (60-83)	4

BLSK – black skimmer = 253 collected, 22% oiling rate.
BRPE – brown pelican = 826 collected, 41% oiling rate.
CLRA – clapper rail = 120 collected, 24% oiling rate.
COLO – common loon = 75 collected, 52% oiling rate.
GRSH – Greater Shearwater = 89 collected, 8% oiling rate.
LAGU – laughing gull = 2981 collected, 40% oiling rate.
LETE – least tern = 106 collected, 46% oiling rate.
NOGA – northern gannet = 475 collected, 63% oiling rate.
ROYT – royal tern = 289 collected, 52% oiling rate.
SATE – sandwich tern = 70 collected, 49% oiling rate.

[a] Data obtained from the Fish and Wildlife Service (USDOI, FWS, 2011a) as part of the *Deepwater Horizon* post-spill monitoring and collection process summarized for May 12, 2011. The data used in this table are verified as per the FWS QA/QC processes. Disclaimer: All data should be considered provisional, incomplete, and subject to change. For more information see the following link to the FWS Weekly Bird Impact Data and Consolidated Wildlife Reports. Numbers in this table have been verified against the original data from the website. Data are available at http://www.fws.gov/home/dhoilspill/pdfs/Bird%20Data%20Species%20Spreadsheet%2005122011.pdf. As of May 12, 2011, 104 avian species had been collected and identified to species through the *Deepwater Horizon* post-spill monitoring and collection process. Note: Though the process was triggered by the *Deepwater Horizon* 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 = 8066) birds collected. Some of the live birds collected may have been incapable of flight due to age or molt, and a large proportion of the dead birds (33.2% = dead-oiled, 53.1%= dead-unoiled, 13.7% = unknown oiling) collected may have died due to causes other than oiling. All species in the table are known breeders in the Gulf of Mexico except the northern gannet and common loon.

[b] The number of birds collected (USDOI, FWS, 2011a) represents a complex interaction of factors including timing, amount, type, and spatial location of an oil spill and its trajectory based on winds and currents. In addition, the abundance, distribution, life-history stage, and behavior for a given species will influence its vulnerability to oiling. Also, search effort will largely determine the number of birds collected, and regardless of the spatial and temporal characteristics of search effort, the number of birds actually collected represents an unknown fraction (recovery rate) of total mortality. Recovery rate is a function of oiling rate, carcass deposition rate, persistence rate, scavenging rate, and detection probability (varies by species, body size, habitat type, etc.). Not all age and sex classes may be equally available or vulnerable to oiling, and population-level impacts of oiling within a species will depend on the age and sex composition of the birds killed. For example, the loss of 2,981 first-year or immature laughing gulls will not impact the population until that cohort reaches breeding age. That is, there will be delayed effect at the population level. Alternatively, if 2,981 adult laughing gulls were killed with a disproportionate loss of breeding-age females, the impact at the population level is almost immediate. Not only will the current nest, its eggs or hatchlings be lost, but also any future reproductive potential to that female. The impact at the population level will continue for ~3-5 years (depending on the species and its age-sex composition) for every breeding-age female lost unless recruitment of females into the population is greater than or equal to the number of breeding-age females lost in that year.

So (%) = percent survival

Table 4-14

Federally Listed Avian Species Considered by State and Associated Planning Area in the Gulf of Mexico[1]

Species	Status	Critical Habitat	States	Planning Area	*Deepwater Horizon*[2]
Red-cockaded woodpecker	Endangered	No rules published	AL, FL, LA, MS, TX	WPA, CPA, EPA	None collected
Least tern	Endangered	No rules published	AL, LA, TX (FL, MS)	WPA, CPA, EPA	**106, 49, 46%****
Piping plover	Threatened	Designated	AL, FL, LA, MS, TX	WPA, CPA, EPA	**1 collected, unoiled**
Roseate tern	Endangered	No rules published	FL only	EPA	None collected
Wood stork	Endangered	No rules published	AL, FL, MS	CPA, EPA	None collected
Whooping crane	Endangered	Designated	TX, LA*, FL*	WPA, CPA, EPA	None collected
Mississippi sandhill crane	Endangered	Designated	MS only	CPA	None collected
Attwater's prairie chicken	Endangered	No rules published	TX only	WPA	None collected
N. Aplomado falcon	Endangered	No rules published	TX only	WPA	None collected
Mountain plover	Threatened	N/A; proposed threatened	TX only	WPA	None collected
Everglades snail kite	Endangered	Designated	FL only	EPA	None collected
Cape Sable seaside sparrow	Endangered	Designated	FL only	EPA	None collected
Sprague's pipit	Candidate	N/A – Priority 2	LA, TX	WPA, CPA	None collected
Bald eagle	Delisted	No rules published	AL, FL, LA, MS, TX	WPA, CPA, EPA	None collected
Peregrine falcon	Delisted	Designated	AL, FL, LA, MS, TX	WPA, CPA, EPA	None collected
Eastern brown pelican	Delisted	No rules published	AL, FL, LA, MS, TX	WPA, CPA, EPA	**826, 339, 41%**
Red knot	Candidate	N/A – Priority 3	FL, LA, TX	WPA, CPA, EPA	None collected

[1] Information contained in this table obtained via email attachment from FWS on February 16, 2011 (USDOI, FWS, 2011b) and from FWS's endangered species website and associated queries for "species" available at (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 least tern, piping plover, whooping crane, brown pelican, and bald eagle will be analyzed. Unless otherwise indicated, if a given species is federally listed, it would be considered a State species of conservation concern in which it occurs.

[2] Data were obtained from FWS as part of the *Deepwater Horizon* post-spill monitoring and collection process summarized for December 14, 2010. The data used in this table are verified as per the FWS QA/QC processes. Disclaimer: All data should be considered provisional, incomplete, and subject to change. For more information, see the Fish and Wildlife Service's "Weekly Bird Impact Data and Consolidated Wildlife Reports" (USDOI, FWS, 2010c). Numbers in this table have been verified against the original data from the website. Numbers in the text refer to the following in order: number collected; number oiled; and oiling rate, respectively (see also **Tables 4-8 and 4-12**).

* The whooping crane is considered endangered throughout its range in the U.S. except where nonessential, experimental flocks have been established. The Gulf Coast States that have these nonessential, experimental flocks include Alabama, Louisiana, Mississippi, and Florida (see pages 4-264 and 4-781); as well wild whooping cranes may rarely occur as transients in Mississippi and Alabama, but they are not known to breed in either state.

** Due to the timing of the oil spill and timing of collections for this species, it is highly probable that all individuals collected were from the non-federally listed subpopulation of least terns breeding in the Gulf of Mexico and not the federally listed Interior Population of least terns.

Table 4-15

Comparison of Oil Spills by Type, Location, Year, and Volume (in U.S. gallons) and Their Relative Impacts to Birds based on Surveys and Modeling[a]

Incident	Type	Location	Year	Volume[b,c]	Bird Surveys[d]	Estimated Mortality[e]
Ixtoc	Blowout	Mexico	1979	145.6 million	>3,000	No research or models[*]
Exxon Valdez	Tanker	Alaska, USA	1989	10.8 million	>30,000	100,000-645,000
Sea Empress	Tanker	Wales, UK	1996	22.1 million	>4,500	No research or models
M/V Citrus	Tanker	Alaska, USA	1996	Unknown	>1,000	1,930
Erika	Tanker	France	1999	6.1 million	>74,000	80,000-150,000
Prestige	Tanker	Spain	2002	19.2 million	>9,000	115,000-300,000
Terra Nova	Rig	Newfoundland, CAN	2004	42,000	No survey	3,593-16,122
M/V Selendang Ayu	Tanker	Alaska, USA	2004	354,218	1,603	Pending[**]
Black Sea	Tanker	Kerch Strait, RUS	2007	1.47 million	>30,000	No research or models
Deepwater Horizon	Blowout	Louisiana, USA	2010	210 million	~7,250	Pending[**]

[a] Since the *Exxon Valdez* oil spill in March 1989, but including the *Ixtoc I* blowout in the Bay of Campeche, Mexico in 1979 (Jernelöv, 2010). See Tables 1-5 in Helm et al. (2008) for additional information. Includes oil spills associated with tankers, barges, wells, rigs-platforms, and blowouts in which bird mortality data are available. This list of spills is not exhaustive but reflects a representative cross-section of oil-spill events across the world over the last ≥20 years. For a more comprehensive review of oil spills, locations, spill volumes, and bird mortality, see Burger (1993, Table 1), Castege et al. (2007, Table 2), Helm et al. (2008, Tables 1-6), and Tan et al. (2010, Table 1).

[b] Volume estimates are in gallons.

[c] Volume estimates were, in some cases, converted from figures cited in a specific reference using the conversion of metric tons to gallons of 7.3 bbl/ton and 42 gallons/bbl (Wilhelm et al., 2007, page 540). In other cases, the figures were pulled from the tables in Helm et al. (2008). Note: Spill volume tends to be a poor predictor of bird mortality associated with an oil spill (Burger, 1993), although 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).

[d] Figures cited in specific references usually as a part of the damage assessment process, including beached-bird surveys, boat- or ship-based surveys, or aerial surveys to collect dead or oiled birds. It has been well documented that, in most cases, survey efforts to collect bird carcasses represent a small fraction of the total mortality for a given oil-spill event. That is, the recovery rate of oiled carcasses is biased low; Burger (1993) and Wiese and Jones (2001) using different methodologies arrived at recovery rate estimates of only 20%. Piatt and Ford (1996) derived a recovery mean rate estimate of only 17% (range 0.0%-59.0%) based on 17 different studies spanning 21 years (1970-1991).

[e] Final estimated mortality typically includes results from drift and carcass experiments plus modeling efforts to account for birds oiled, but "unavailable" to be detected; that is, a correction for detection and scavenging bias, deposition and persistence rates, and the effects of wind, currents, weather, topography, and habitat. See Flint and Fowler (1998), Flint et al. (1999), Castège et al. (2007), Wilhelm et al. (2007), Byrd et al. (2009), and other references herein for additional information regarding biases associated with mortality estimates from carcass surveys only.

[*] Literature searches on the Internet revealed only 2 avian-related references as a result of the *Ixtoc I* oil spill — Chapman (1981) and Chapman (1984).

[**] Pending results of the NRDA process and litigation regarding damage claims against litigants; see also Helm et al. (2006 and 2008).

Table 4-16

Managed Species in the Gulf of Mexico

Red Drum Fishery	Reef Fish Fishery (continued)
red drum (*Sciaenops ocellatus*)	blueline tilefish (*Caulolatilus microps*)
	anchor tilefish (*Caulolatilus intermedius*)
Reef Fish Fishery	tilefish (*Lopholatilus chamaeleonticeps*)
blackfin snapper (*Lutjanus buccanella*)	
cubera snapper (*Lutjanus cyanopterus*)	hogfish (*Lachnolaimus maximus*)
dog snapper (*Lutjanus jocu*)	
gray snapper (*Lutjanus griseus*)	dwarf sand perch (*Diplectrum bivittatum*)
lane snapper (*Lutjanus synagris*)	sand perch (*Diplectrum formosum*)
mahogany snapper (*Lutjanus mahogoni*)	
mutton snapper (*Lutjanus analis*)	Coastal Migratory Pelagic Fishes
schoolmaster (*Lutjanus apodus*)	bluefish (*Pomatomus saltatrix*)
queen snapper (*Etelis oculatus*)	cero (*Scomberomorus regalis*)
red snapper (*Lutjanus campechanus*)	cobia (*Rachycentron canadum*)
silk snapper (*Lutjanus vivanus*)	dolphin (*Coryphaena hippurus*)
vermilion snapper (*Rhomboplites aurorubens*)	king mackerel (*Scomberomorus cavalla*)
yellowtail snapper (*Ocyurus chrysurus*)	little tunny (*Euthynnus alleteratus*)
wenchman (*Pristipomoides aquilonaris*)	Spanish mackerel (*Scomberomorus maculatus*)
black grouper (*Mycteroperca bonaci*)	Corals
gag (*Mycteroperca microlepis*)	Class Hydrozoa (stinging and hydrocorals)
misty grouper (*Epinephelus mystacinus*)	Class Anthozoa (sea fans, whips, precious coral, sea pen, stony corals)
Nassau grouper (*Epinephelus striatus*)	
red grouper (*Epinephelus morio*)	Invertebrate Fishery
red hind (*Epinephelus guttatus*)	brown shrimp (*Farfantepenaeus aztecus*)
rock hind (*Epinephelus adscensionis*)	pink shrimp (*Farfantepenaeus duorarum*)
scamp (*Mycteroperca phenax*)	royal red shrimp (*Pleoticus robustus*)
speckled hind (*Epinephelus drummondhayi*)	spiny lobsters (*Panulirus argus*)
snowy grouper (*Epinephelus niveatus*)	slipper lobsters (*Scyllarides nodife*)
yellowedge grouper (*Epinephelus flavolimbatus*)	stone crab (*Menippe* spp.)
yellowfin grouper (*Mycteroperca venenosa*)	white shrimp (*Litopenaeus setiferus*)
yellowmouth grouper (*Mycteroperca interstitialis*)	
	Highly Migratory Species
greater amberjack (*Seriola dumerili*)	albacore (*Thunnus alalunga*)
lesser amberjack (*Seriola fasciata*)	Atlantic bluefin tuna (*Thunnus thynnus*)
almaco jack (*Seriola rivoliana*)	Atlantic bigeye tuna (*Thunnus obesus*)
banded rudderfish (*Seriola zonata*)	Atlantic yellowfin tuna (*Thunnus albacares*)
	skipjack (*Katsuwonus pelamis*)
gray triggerfish (*Balistes capriscus*)	
	swordfish (*Xiphias gladius*)
goldface tilefish (*Caulolatilus chrysops*)	
blackline tilefish (*Caulolatilus cyanops*)	

Table 4-16. Managed Species in the Gulf of Mexico (continued).

Highly Migratory Species (continued)	Highly Migratory Species (continued)
blue marlin (*Makaira nigricans*)	sand tiger shark (*Odontaspis taurus*)
sailfish (*Istiophorus platypterus*)	whale shark (*Rhinocodon typus*)
white marlin (*Tetrapturus albidus*)	Atlantic angel shark (*Squatina dumerili*)
longbill spearfish (*Tetrapturus pfluegeri*)	bonnethead shark (*Sphyrna tiburo*)
	Atlantic sharpnose (*Rhinocodon terraenovae*)
basking shark (*Cetorhinus maximus*)	blacknose shark (*Carcharhinus acronotus*)
great hammerhead (*Sphyrna mokarran*)	Caribbean sharpnose shark (*Rhinocodon porosus*)
scalloped hammerhead (*Sphyrna lewini*)	finetooth shark (*Carcharhinus isodon*)
smooth hammerhead (*Sphyrna zygaena*)	smalltail shark (*Carcharhinus porosus*)
white shark (*Carcharodon carcharias*)	bigeye sixgill shark (*Hexanchus vitulus*)
nurse chark (*Ginglymostoma cirratum*)	sevengill shark (*Heptranchias perlo*)
bignose shark (*Carcharhinus altimus*)	sixgill shark (*Heptranchias griseus*)
blacktip shark (*Carcharhinus limbatus*)	longfin mako shark (*Isurus paucus*)
bull shark (*Carcharhinus leucas*)	shortfin mako shark (*Isurus oxyrinchus*)
Caribbean reef shark (*Carcharhinus perezi*)	blue shark (*Prionace glauca*)
dusky shark (*Carcharhinus obscurus*)	oceanic whitetip shark (*Carcharhinus longimanu*)
Galapagos shark (*Carcharhinus galapagensis*)	bigeye thresher shark (*Alopias superciliosus*)
lemon shark (*Negaprion brevirostris*)	common thresher shark (*Alopias vulpinus*)
narrowtooth shark (*Carcharhinus brachyurus*)	
night shark (*Carcharhinus signatus*)	**Other Species of Importance**
sandbar shark (*Carcharhinus plumbeus*)	striped mullet (*Mugil cephalus*)
silky shark (*Carcharhinus falciformis*)	white mullet (*Mugil curema*)
spinner shark (*Carcharhinus brevipinna*)	Gulf menhaden (*Brevoortia patronus*)
tiger shark (*Galeocerdo cuvieri*)	blue crab (*Callinectes sapidus*)
bigeye sand shark (*Odontaspis noronhai*)	oyster (*Cassostrea virginica*)

Sources: GMFMC, 2004; USDOC, NMFS, 2010.

Table 4-17

Economic Significance of Commercial Fishing in the Gulf of Mexico

State	Landings Revenue	Sales Impacts	Job Impacts	CFQ
Alabama	40,530	391,300	8,759	0.44
Florida	116,091	12,988,379	64,744	0.97
Louisiana	284,425	1,691,033	29,185	2.19
Mississippi	37,998	289,241	6,392	1.96
Texas	150,232	1,682,135	18,874	0.27
Total	629,276	17,042,088	127,954	--

Note: Landings revenue and sales impacts are presented in thousands of dollars.
CFQ = commercial fishing quotient

Source: USDOC, NMFS, 2011a.

Table 4-18

Top Species Landed by Recreational Fishermen

Panel A: Total Landings					Panel B: Landings in Bays				
Species	2007	2008	2009	2010	Species	2007	2008	2009	2010
Atlantic Croaker	95	64	117	124	Atlantic Croaker	95	64	117	124
Black Drum	66	82	98	165	Black Drum	65	80	97	164
King Mackerel	11	8	16	6	King Mackerel	--	--	--	--
Red Drum	289	267	285	264	Red Drum	286	262	277	261
Red Snapper	45	39	31	33	Red Snapper	--	--	--	--
Sand Seatrout	95	152	111	127	Sand Seatrout	89	137	108	126
Sheepshead	46	46	34	49	Sheepshead	46	46	34	49
Southern Flounder	49	64	47	30	Southern Flounder	49	64	47	30
Spotted Seatrout	916	920	810	732	Spotted Seatrout	892	895	789	721
Panel C: Landings in State Waters					Panel D: Landings in EEZ				
Species	2007	2008	2009	2010	Species	2007	2008	2009	2010
Atlantic Croaker	--	--	--	--	Atlantic Croaker	--	--	--	--
Black Drum	1	2	1	--	Black Drum	--	--	--	1
King Mackerel	3	5	7	5	King Mackerel	8	4	9	1
Red Drum	3	4	8	--	Red Drum	0	0	1	3
Red Snapper	18	28	13	12	Red Snapper	27	13	19	21
Sand Seatrout	6	13	2	1	Sand Seatrout	--	1	1	1
Sheepshead	--	--	--	--	Sheepshead	--	--	--	--
Southern Flounder	--	--	--	--	Southern Flounder	--	--	--	--
Spotted Seatrout	23	18	14	--	Spotted Seatrout	1	5	8	10

Notes: Fish landings are measured in thousands of fish.
EEZ = Exclusive Economic Zone.

Source: Texas Parks and Wildlife Department, 2011.

Table 4-19

Number of Angler Trips in 2010

Area	Private	Charter	Total
Bay	823,517	117,220	940,737
Texas (Territorial) State Waters	26,087	4,239	30,326
Exclusive Economic Zone	14,873	1,602	16,475
Total	864,476	123,061	987,537

Source: Texas Parks and Wildlife Department, 2011.

Table 4-20

Number of Angler Trips in 2009 and 2010

2009								
Season A					Season B			
Area	Private	Charter	Total		Area	Private	Charter	Total
Bay	291,400	33,256	324,655		Bay	573,978	82,242	656,220
TTS	3,804	431	4,235		TTS	29,060	2,394	31,454
EEZ	252	0	252		EEZ	20,874	3,336	24,211
Total	295,456	33,687	329,143		Total	623,912	87,972	711,885
2010								
Season A					Season B			
Area	Private	Charter	Total		Area	Private	Charter	Total
Bay	255,995	23,570	279,565		Bay	567,522	93,650	661,171
TTS	3,250	2,187	5,437		TTS	22,837	2,052	24,888
EEZ	744	0	744		EEZ	14,129	1,602	15,731
Total	259,989	25,758	285,747		Total	604,487	97,303	701,791

Notes: Season A is November 21 through May 14. Season B is May 15 through November 20.
EEZ = Exclusive Economic Zone.
TTS = Texas (Territorial) State Waters.

Source: Texas Parks and Wildlife Department, 2011.

Table 4-21

Economic Impact of Recreational Fishing in the Gulf of Mexico in 2009

State	Expenditures	Sales	Value Added	Employment
Alabama	501,594	474,746	245,437	4,924
West Florida	4,837,871	4,369,022	2,385,738	42,314
Mississippi	446,760	417,080	162,099	3,188
Louisiana	2,080,443	1,774,692	894,123	19,688
Texas	2,244,579	2,846,858	1,434,733	22,127
Total	10,111,247	9,882,398	5,122,130	92,241

Note: Expenditure, sales, and value-added are presented in thousands of dollars.

Source: USDOC, NMFS, 2011a.

Table 4-22

Top Species Landed by Recreational Fisherman in Texas – Seasonal

Panel A: Total Landings					Panel B: Landings in Bays				
	2009		2010			2009		2010	
Species	Season A	Season B	Season A	Season B	Species	Season A	Season B	Season A	Season B
Atlantic Croaker	12	105	8	117	Atlantic Croaker	12	105	8	117
Black Drum	38	59	36	128	Black Drum	38	59	36	127
King Mackerel	--	16	--	6	King Mackerel	--	--	--	--
Red Drum	93	193	58	206	Red Drum	89	188	58	203
Red Snapper	2	30	11	22	Red Snapper	--	--	--	--
Sand Seatrout	21	90	16	112	Sand Seatrout	21	87	16	110
Sheepshead	26	8	40	10	Sheepshead	26	8	40	10
Southern Flounder	12	36	--	25	Southern Flounder	12	36	--	25
Spotted Seatrout	179	631	124	607	Spotted Seatrout	179	610	124	597

Panel C: Landings in State Waters					Panel D: Landings in EEZ				
	2009		2010			2009		2010	
Species	Season A	Season B	Season A	Season B	Species	Season A	Season B	Season A	Season B
Atlantic Croaker	--	0	--	--	Atlantic Croaker	--	--	--	--
Black Drum	--	0	--	1	Black Drum	--	--	--	--
King Mackerel	--	7	--	1	King Mackerel	--	9	--	5
Red Drum	4	4	--	3	Red Drum	--	1	--	--
Red Snapper	2	11	10	11	Red Snapper	--	19	1	11
Sand Seatrout	--	2	--	1	Sand Seatrout	--	1	--	1
Sheepshead	--	0	--	--	Sheepshead	--	--	--	--
Southern Flounder	--	0	--	--	Southern Flounder	--	--	--	--
Spotted Seatrout	--	13	--	10	Spotted Seatrout	--	8	--	--

Source: Texas Parks and Wildlife Department, 2011

1) Fish landings are measured in thousands of fish.

2) Season A is November 21 through May 14. Season B is May 15 through November 20.

Table 4-23

Employment in the Leisure/Hospitality Industry in Selected Geographic Regions

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009
Panel A — Economic Impact Area									
TX-1	45,553	46,979	48,490	49,165	50,446	53,281	54,654	54,551	53,691
TX-2	14,055	14,113	14,241	14,728	14,670	16,153	16,564	16,883	16,702
TX-3	195,214	203,090	207,245	214,025	219,203	231,840	241,110	240,231	240,366
LA-1	13,682	14,065	14,300	14,725	15,339	14,747	14,563	14,295	14,246
LA-2	17,653	17,451	18,560	19,817	20,787	21,072	21,517	21,364	20,588
LA-3	37,902	38,048	40,752	42,229	43,483	44,533	44,810	46,037	44,157
LA-4	80,990	80,677	81,243	85,093	47,641	64,812	68,531	68,605	67,438
MS-1	31,485	32,752	33,714	33,297	18,024	29,191	29,680	27,702	26,938
AL-1	23,785	23,937	24,488	24,464	25,481	26,463	26,850	26,516	26,034
FL-1	34,829	36,139	36,520	39,956	41,133	41,887	41,688	40,001	41,003
FL-2	17,934	19,733	18,860	21,588	21,861	22,478	22,913	22,502	21,699
FL-3	123,248	130,250	132,256	137,302	145,005	145,894	149,448	146,368	142,393
FL-4	238,090	251,658	256,472	268,487	274,635	280,874	283,748	283,359	280,380
TX EIA Total	254,822	264,182	269,976	277,918	284,319	301,274	312,328	311,665	310,759
LA EIA Total	150,227	150,241	154,855	161,864	127,250	145,164	149,421	150,301	146,429
MS EIA Total	31,485	32,752	33,714	33,297	18,024	29,191	29,680	27,702	26,938
AL EIA Total	23,785	23,937	24,488	24,464	25,481	26,463	26,850	26,516	26,034
FL EIA Total	414,101	437,780	444,108	467,333	482,634	491,133	497,797	492,230	485,475
EIA Total	874,420	908,892	927,141	964,876	937,708	993,225	1,016,076	1,008,414	995,635
Panel B — Coastal									
TX	57,637	59,250	60,873	61,983	63,069	67,625	68,195	67,388	68,025
LA	88,235	87,640	88,431	92,703	56,242	73,405	77,567	77,580	75,958
MS	30,052	31,295	32,172	31,625	16,152	26,926	27,444	25,575	25,080
AL	21,231	21,690	22,249	22,250	23,099	24,186	24,437	24,319	23,990
FL	377,323	399,122	404,048	423,855	437,761	445,948	450,414	445,164	441,068
Coastal Total	574,478	598,997	607,773	632,416	596,323	638,090	648,057	640,026	634,121
Panel C — Statewide									
TX	818,164	840,506	854,733	877,284	900,646	943,581	982,437	995,445	982,122
LA	191,394	192,342	198,195	206,298	171,674	189,822	194,614	194,905	189,527
MS	116,714	120,243	121,528	122,557	110,430	123,402	125,192	121,033	115,924
AL	148,989	149,172	154,287	158,390	163,390	168,558	171,697	168,413	166,237
FL	772,721	808,429	817,571	866,269	893,043	912,409	932,012	922,534	896,923
State Total	2,047,982	2,110,692	2,146,314	2,230,798	2,239,183	2,337,772	2,405,952	2,402,330	2,350,733

Notes:

(1) Economic Impact Areas (EIA's) are defined in **Figure 4-20**.
(2) The "Coastal" category refers to the counties within the 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.
(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, 2010.

Table 4-24

Total Wages Earned by Employees in the Leisure/Hospitality Industry in Selected Geographic Regions

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009
Panel A — Economic Impact Area									
TX-1	516,185	544,244	566,896	586,252	627,083	685,028	739,142	746,670	766,750
TX-2	148,743	155,321	158,437	168,256	175,260	190,740	209,082	221,889	237,274
TX-3	3,018,006	3,184,819	3,269,332	3,482,253	3,711,467	4,067,402	4,341,536	4,559,854	4,635,997
LA-1	179,049	190,839	196,760	207,015	252,162	250,432	251,148	257,990	263,543
LA-2	176,741	186,845	195,892	219,352	243,347	280,120	295,347	308,107	314,147
LA-3	446,102	452,046	487,564	498,022	543,970	597,138	633,241	654,806	667,398
LA-4	1,318,417	1,378,771	1,429,488	1,493,019	1,409,983	1,246,477	1,505,206	1,633,224	1,595,567
MS-1	591,065	591,974	608,043	618,987	617,535	453,168	621,439	616,442	560,510
AL-1	281,331	287,381	300,006	305,922	321,934	347,512	371,712	388,644	390,968
FL-1	470,616	508,316	528,008	599,949	655,141	721,483	761,247	738,910	743,731
FL-2	182,944	209,213	210,758	232,143	249,152	270,339	294,144	293,528	291,417
FL-3	1,849,168	1,956,066	2,046,441	2,224,235	2,418,168	2,576,029	2,752,991	2,906,630	2,795,652
FL-4	4,219,638	4,391,881	4,669,982	5,131,115	5,650,225	5,981,862	6,304,312	6,493,402	6,344,752
TX EIA Total	3,682,934	3,884,384	3,994,665	4,236,761	4,513,810	4,943,170	5,289,760	5,528,413	5,640,021
LA EIA Total	2,120,309	2,208,501	2,309,704	2,417,408	2,449,462	2,374,167	2,684,942	2,854,127	2,840,655
MS EIA Total	591,065	591,974	608,043	618,987	617,535	453,168	621,439	616,442	560,510
AL EIA Total	281,331	287,381	300,006	305,922	321,934	347,512	371,712	388,644	390,968
FL EIA Total	6,722,366	7,065,476	7,455,189	8,187,442	8,972,686	9,549,713	10,112,694	10,432,470	10,175,552
EIA Total	13,398,005	14,037,716	14,667,607	15,766,520	16,875,427	17,667,730	19,080,547	19,820,096	19,607,706
Panel B — Coastal									
TX	706,679	737,035	761,880	790,346	834,820	927,109	986,605	994,817	1,027,931
LA	1,401,025	1,459,632	1,512,219	1,578,886	1,503,750	1,359,770	1,631,966	1,764,631	1,734,276
MS	579,122	579,914	595,776	605,542	602,391	433,995	600,226	594,626	539,240
AL	259,024	265,870	279,872	284,844	299,662	324,127	347,209	363,802	367,039
FL	6,309,393	6,624,756	6,991,895	7,687,112	8,410,661	8,955,648	9,456,949	9,762,721	9,522,041
Coastal Total	9,255,243	9,667,207	10,141,642	10,946,730	11,651,284	12,000,649	13,022,955	13,480,597	13,190,527
Panel C — Statewide									
TS	12,226,217	12,630,640	12,936,441	13,601,748	14,407,978	15,653,469	16,677,752	17,490,862	17,674,963
LA	2,674,740	2,762,055	2,886,189	3,028,338	3,069,485	3,013,979	3,336,193	3,530,708	3,511,171
MS	1,714,340	1,746,899	1,778,922	1,840,583	1,872,402	1,789,900	1,990,974	2,024,034	1,915,700
AL	1,682,365	1,730,048	1,800,093	1,882,015	1,998,089	2,124,157	2,244,583	2,344,058	2,345,332
FL	13,388,764	13,677,833	14,336,358	15,686,585	17,089,645	18,132,360	19,354,496	19,990,305	19,103,860
State Total	31,686,426	32,547,475	33,738,003	36,039,269	38,437,599	40,713,865	43,603,998	45,379,967	44,551,026

Notes:
(1) Economic Impact Areas (EIA’s) are defined in **Figure 4-20**.
(2) The “Coastal” category refers to the counties within the 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.
(5) Wages are presented in thousands of dollars.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2010.

Table 4-25

Total Tourism Spending in Gulf Coast States

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Texas	36,753	35,106	34,238	34,589	37,065	40,790	44,707	44,428	50,874	47,220
Louisiana	9,227	9,266	9,262	9,418	9,964	8,248	6,718	9,021	9,642	8,942
Mississippi	5,282	5,227	5,345	5,489	5,755	5,939	5,633	6,060	6,329	5,897
Alabama	5,487	5,423	5,368	5,627	6,051	6,639	6,998	7,405	7,723	7,205
Florida	60,296	56,166	54,544	56,265	61,118	64,544	66,165	68,870	70,521	64,027

Note: Data are presented in millions of dollars.

Source: U.S. Travel Association, 2011.

Table 4-26

Coastal Travel, Tourism, and Recreation Estimates in 2004

State	Employees	Payroll	Establishments
Texas	13,712	$366,374	1,626
Louisiana	4,362	$158,357	544
Mississippi	12,188	$192,864	148
Alabama	1,078	$35,407	212
Florida	31,166	$721,440	2,398
Gulf Total	62,506	$1,474,442	4,928

Note: Payroll is presented in thousands of dollars.

Source: Kaplan and Whitman, unpublished.

Table 4-27

Categories of Tourism Spending in Texas

Category	1994	2002	2004	2006	2007	2008	2009
Accommodations	929	1,507	1,571	2,020	2,192	2,424	2,041
Food Service	1,183	1,793	1,939	2,288	2,418	2,571	2,449
Food Stores	272	387	422	480	510	545	521
Local Transportation and Gas	1,224	1,763	2,291	3,295	3,610	4,126	2,831
Arts, Entertainment, and Recreation	803	1,184	1,252	1,426	1,464	1,501	1,399
Retail Sales	1,152	1,631	1,631	1,813	1,844	1,847	1,745
Visitor Air Transportation	476	697	761	864	888	869	701
Other Travel Spending	1,725	2,541	2,629	2,971	2,996	3,145	2,819
Total Tourist Spending	7,764	11,504	12,496	15,157	15,923	17,027	14,506

Note: Data are in millions of dollars.

Source: Dean Runyan Associates, 2010.

Table 4-28

Tourism in Gulf Coast Regions of Texas in 2009

Metro Area	Visitors	Spending
Beaumont/Port Arthur	2.60	557
Corpus Christi	6.61	1,030
Houston/Baytown/Sugarland	29.85	12,431
Victoria	1.51	190
Brownsville/Harlingen	1.85	663

Notes:
(1) Visitors are presented in millions of visitors.
(2) Spending is presented in millions of dollars.

Sources: Dean Runyan Associates, 2010; D.K. Shifflet and Associates, 2010.

Table 4-29

Number of Beaches and Annual Beach Participation in the Gulf Coast States

State	Number of Beaches	Beach Visitation
Texas	168	4,929,000
Louisiana	28	578,000
Mississippi	20	956,000
Alabama	25	1,527,000
Florida	634	21,989,000

Notes:
(1) The number of beaches is from USEPA (2008).
(2) Beach visitation data comes from National Survey on Recreation and the Environment (Betz, official communication, 2010).
(3) Beach visitation only refers to visitors originating from within the U.S.

Table 4-30

Deepwater Horizon Damage Claims in Texas

Panel A: Individual Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	892	12,156,671.30
Food, Beverage, and Lodging	247	1,899,506.79
Multiple Industry/Business Types	42	523,540.00
No Industry Designation	10	114,579.00
Rental Property	33	278,900.00
Retail, Sales, and Service	448	8,130,329.92
Seafood Processing and Distribution	541	4,550,644.16
Tourism and Recreation	9	131,500.00
Total	2,222	27,785,671.17

Panel B: Business Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	1,172	40,528,508.88
Food, Beverage, and Lodging	16	1,707,100.00
Multiple Industry/Business Types	4	129,500.00
No Industry Designation	30	463,984.53
Rental Property	350	5,100,500.00
Retail, Sales, and Service	55	12,656,700.00
Seafood Processing and Distribution	80	30,296,300.00
Tourism and Recreation	2	31,200.00
Total	1,709	90,913,793.41

Claims data are as of April 9, 2011.

Source: Gulf Coast Claims Facility, 2011a.

Table 4-31

Monthly Employment in the Leisure/Hospitality Industry During 2010

Region	Jan	Feb	March	April	May	June	July	Aug	Sep
Economic Impact Area									
TX-1	53,780	54,864	56,434	56,712	57,682	57,817	56,989	56,821	56,106
TX-2	16,372	16,535	16,879	17,357	17,488	17,953	17,744	17,668	17,234
TX-3	233,323	236,395	242,381	245,096	248,306	250,958	248,351	248,857	246,488
LA-1	14,195	14,203	14,435	14,500	14,698	14,774	14,632	14,402	14,487
LA-2	20,441	20,790	21,107	21,666	21,934	21,640	21,319	21,259	21,210
LA-3	42,988	43,485	44,710	44,925	45,606	45,695	45,320	45,556	45,492
LA-4	68,343	68,806	70,051	70,708	70,570	71,257	70,173	70,590	70,982
MS-1	26,404	26,645	27,211	27,583	27,879	28,290	28,052	27,981	27,570
AL-1	25,435	25,925	27,140	28,316	28,962	29,503	28,836	28,571	27,961
FL-1	40,374	42,431	46,703	48,351	49,119	50,806	49,889	48,372	46,160
FL-2	21,621	22,074	22,478	22,868	22,011	21,550	21,238	21,504	22,090
FL-3	142,690	145,777	149,670	150,654	149,325	148,017	145,285	145,267	145,346
FL-4	280,126	285,916	291,067	290,144	284,324	279,782	272,745	272,263	270,061
TX EIA Total	303,475	307,794	315,694	319,165	323,476	326,728	323,084	323,346	319,828
LA EIA Total	145,967	147,284	150,303	151,799	152,808	153,366	151,444	151,807	152,171
MS EIA Total	26,404	26,645	27,211	27,583	27,879	28,290	28,052	27,981	27,570
AL EIA Total	25,435	25,925	27,140	28,316	28,962	29,503	28,836	28,571	27,961
FL EIA Total	484,811	496,198	509,918	512,017	504,779	500,155	489,157	487,406	483,657
EIA Total	986,092	1,003,846	1,030,266	1,038,880	1,037,904	1,038,042	1,020,573	1,019,111	1,011,187
Coastal									
TX	66,575	67,809	70,159	71,833	72,737	73,916	72,832	72,110	70,337
LA	76,571	77,167	78,666	79,306	79,329	79,933	78,923	79,373	79,764
MS	24,585	24,803	25,313	25,675	25,972	26,376	26,249	26,153	25,750
AL	23,425	23,908	25,020	26,192	26,734	27,202	26,551	26,324	25,732
FL	440,714	451,034	464,086	465,718	460,000	456,131	445,905	443,901	438,708
Coastal Total	631,870	644,721	663,244	668,724	664,772	663,558	650,460	647,861	640,291
Statewide									
TX	955,907	971,203	993,927	1,007,287	1,025,007	1,035,662	1,024,465	1,026,375	1,017,550
LA	187,935	189,633	193,519	195,715	196,978	197,360	194,930	195,358	195,476
MS	113,199	114,644	117,222	119,567	120,425	121,213	119,571	120,795	119,569
AL	160,117	160,637	165,671	169,475	171,307	172,834	170,998	171,144	168,839
FL	893,174	915,016	937,711	942,916	934,556	926,893	910,396	907,547	901,179
State Total	2,310,332	2,351,133	2,408,050	2,434,960	2,448,273	2,453,962	2,420,360	2,421,219	2,402,613

(1) Economic Impact Areas (EIA's) are defined in **Figure 4-20**.
(2) The "Coastal" category refers to the counties within the 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.
(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, 2011a.

Table 4-32

Quarterly Wages in the Leisure/Hospitality Industry in 2009 and 2010

	2009				2010		
Region	Q1	Q2	Q3		Q1	Q2	Q3
Economic Impact Area							
TX-1	186,485	190,705	196,907		189,011	200,118	202,891
TX-2	55,947	59,888	60,406		56,807	62,136	62,005
TX-3	1,101,383	1,156,040	1,172,061		1,101,259	1,182,646	1,205,761
LA-1	66,498	62,427	68,772		67,858	63,177	69,412
LA-2	76,903	79,958	78,659		74,803	82,036	82,804
LA-3	146,758	147,760	151,476		146,165	155,619	157,535
LA-4	399,037	375,763	372,045		422,006	393,554	389,661
MS-1	139,067	139,486	144,690		137,586	138,553	144,858
AL-1	90,350	101,085	102,964		90,985	105,881	107,282
FL-1	165,362	199,059	208,098		161,938	201,780	203,336
FL-2	72,448	73,443	71,806		68,942	72,564	72,652
FL-3	704,036	685,052	661,734		683,879	706,460	704,891
FL-4	1,644,155	1,582,097	1,455,292		1,614,884	1,639,368	1,543,834
TX EIA Total	1,343,815	1,406,633	1,429,374		1,347,077	1,444,900	1,470,657
LA EIA Total	689,196	665,908	670,952		710,832	694,386	699,412
MS EIA Total	139,067	139,486	144,690		137,586	138,553	144,858
AL EIA Total	90,350	101,085	102,964		90,985	105,881	107,282
FL EIA Total	2,586,001	2,539,651	2,396,930		2,529,643	2,620,172	2,524,713
EIA Total	4,848,429	4,852,763	4,744,910		4,816,123	5,003,892	4,946,922
Coastal							
TX	242,514	258,365	266,840		245,102	271,683	274,253
LA	413,709	389,122	386,512		439,668	412,408	408,835
MS	133,736	134,172	139,231		132,549	133,384	139,556
AL	84,665	95,019	96,792		85,260	99,780	100,742
FL	2,423,701	2,377,078	2,234,861		2,371,990	2,454,904	2,360,412
Coastal Total	3,298,325	3,253,756	3,124,236		3,274,569	3,372,159	3,283,798
Statewide							
TX	4,309,905	4,381,324	4,412,854		4,261,565	4,470,937	4,596,176
LA	864,759	851,017	856,394		884,745	883,392	890,067
MS	466,911	482,749	482,404		456,300	486,254	495,765
AL	548,550	592,439	600,567		549,179	608,297	608,426
FL	4,816,481	4,795,973	4,515,640		4,769,647	4,895,534	4,791,884
State Total	11,006,606	11,103,502	10,867,859		10,921,436	11,344,414	11,382,318

Notes
(1) Economic Impact Areas (EIA's) are defined in **Figure 4-20**.
(2) The "Coastal" category refers to the counties within the 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.
(5) Wages are presented in thousands of dollars.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2011a.

Table 4-33

Shipwrecks in the Western Planning Area

Map Area	No. of Recorded Wrecks	Historic Wrecks (verified)
Alaminos Canyon	1	0
Brazos	62	0
Corpus Christi	3	0
East Breaks	6	0
Galveston	119	1
Garden Banks	1	0
High Island	111	1
Keathley Canyon	1	0
Matagorda Island	45	1
Mustang Island	72	0
North Padre Island	39	0
South Padre Island	53	0
Sabine Pass (Texas)	2	0
Total	515	3

Table 4-34

Classification of the Gulf Economic Impact Areas

State	Economic Area	Labor Market	County/Parish	State	Economic Area	Labor Market	County	State	Economic Area	Labor Market	County
Alabama	AL-1	Mobile	Baldwin	Texas	TX-1	Brownsville	Cameron	Florida	FL-1	Panama City	Bay
			Clarke				Hidalgo				Franklin
			Conecuh				Starr				Gulf
			Escambia				Willacy			Pensacola	Escambia
			Mobile			Corpus Christi	Aransas				Okaloosa
			Monroe				Brooks				Santa Rosa
			Washington				Duval				Walton
			Wilcox				Jim Wells		FL-2	Tallahassee	Calhoun
							Kenedy				Gadsden
Mississippi	MS-1	Biloxi-Gulfport	George				Kleberg				Holmes
			Greene				Nueces				Jackson
			Hancock				Refugio				Jefferson
			Harrison				San Patricio				Leon
			Jackson		TX-2	Brazoria	Brazoria				Liberty
			Pearl River				Matagorda				Wakulla
			Stone				Wharton				Washington
						Victoria	Calhoun			Lake City	Columbia
Louisiana	LA-1	Lake Charles	Allen				Colorado				Hamilton
			Beauregard				Dewitt				Lafayette
			Calcasieu				Fayette				Madison
			Cameron				Goliad				Suwannee
			Jefferson Davis				Gonzales				Taylor
			Vernon				Jackson		FL-3	Ocala	Citrus
	LA-2	Lafayette	Acadia				Lavaca				Marion
			Evangeline				Victoria			Gainesville	Alachua
			Iberia		TX-3	Beaumont -	Hardin				Bradford
			Lafayette			Port Arthur	Jasper				Dixie
			St. Landry				Jefferson				Gilchrist
			St. Martin				Newton				Levy
			Vermillion				Orange				Union

Table 4-34. Classification of the Gulf Economic Impact Areas (continued).

State	Economic Area	Labor Market	County/Parish	State	Economic Area	Labor Market	County	State	Economic Area	Labor Market	County
Louisiana	LA-3	Baton Rouge	Ascension	Texas	TX-3		Polk	Florida	FL-3	Tampa- St. Petersburg	Hernando
			East Baton Rouge				Tyler				Hillsborough
			Iberville			Houston - Galveston	Austin				Pasco
			Livingston				Chambers				Pinellas
			Tangipahoa				Fort Band		FL-4	Ft. Myers	Collier
			West Baton Rouge				Galveston				Lee
		Houma	Assumption				Harris			Miami	Broward
			Lafourche				Liberty				Miami-Dade
			St. Mary				Montgomery				Monroe
			Terrebonne				San Jacinto			Sarasota	Charlotte
	LA-4	New Orleans	Jefferson				Waller				De Soto
			Orleans				Washington				Manatee
			Plaquemines								Sarasota
			St. Bernard								
			St. Charles								
			St. James								
			St. John the Baptist								
			St. Tammany								
			Washington								

Table 4-35

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)	1,625.42	1,771.25	1,807.15	1,843.24	1,879.50	1,915.95	1,952.51	2,137.01	2,323.71	2,511.01	2,886.77
Age Under 19 Years	36.1%	36.4%	36.4%	36.4%	36.4%	36.4%	36.4%	36.6%	35.7%	34.9%	33.6%
Age 20 to 34	21.0%	20.2%	20.0%	20.0%	19.9%	19.9%	19.8%	18.8%	19.2%	19.6%	20.1%
Age 35 to 49	18.7%	18.0%	17.8%	17.6%	17.4%	17.3%	17.1%	17.1%	16.5%	16.3%	15.9%
Age 50 to 64	13.5%	14.6%	14.8%	14.8%	14.9%	14.9%	14.8%	14.5%	14.3%	13.8%	13.6%
Age 65 and over	10.7%	10.9%	11.0%	11.2%	11.4%	11.6%	11.9%	13.1%	14.3%	15.4%	16.8%
Median Age of Population (years)	33	34	34	34	35	35	35	36	36	37	38
White Population (in thousands)	18.7%	16.8%	16.4%	16.1%	15.8%	15.5%	15.3%	14.1%	13.1%	12.3%	11.2%
Black Population (in thousands)	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.0%
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)	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Hispanic or Latino Population (in thousands)	79.0%	80.9%	81.2%	81.5%	81.9%	82.1%	82.4%	83.7%	84.7%	85.5%	86.8%
Male Population (in thousands)	48.7%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%
Total Employment (in thousands of jobs)	728.91	840.00	864.86	878.23	891.81	905.55	919.48	991.85	1,069.01	1,151.17	1,331.45
Farm Employment	1.7%	1.6%	1.6%	1.5%	1.5%	1.5%	1.4%	1.3%	1.2%	1.1%	0.9%
Forestry, Fishing, Related Activities	1.2%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	0.9%	0.8%	0.7%
Mining	1.8%	2.4%	2.4%	2.3%	2.3%	2.3%	2.3%	2.1%	2.0%	1.8%	1.6%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%
Construction	7.2%	6.0%	6.0%	6.0%	5.9%	5.9%	5.9%	5.8%	5.8%	5.7%	5.5%
Manufacturing	4.0%	3.2%	3.1%	3.1%	3.0%	3.0%	3.0%	2.7%	2.5%	2.3%	2.0%
Wholesale Trade	2.8%	2.4%	2.4%	2.3%	2.3%	2.3%	2.3%	2.1%	2.0%	1.9%	1.7%
Retail Trade	12.0%	11.4%	11.4%	11.3%	11.3%	11.3%	11.2%	11.1%	10.9%	10.7%	10.3%
Transportation and Warehousing	3.3%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.3%	3.3%	3.3%

Table 4-35. Demographic and Employment Baseline Projections for Economic Impact Area TX-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Information Employment	1.2%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%
Finance and Insurance	3.1%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
Real Estate /Rental and Lease	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	3.0%	3.0%	3.0%
Professional and Technical Services	3.4%	3.2%	3.2%	3.2%	3.2%	3.3%	3.3%	3.4%	3.5%	3.7%	3.9%
Management	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%
Administrative and Waste Services	5.4%	5.6%	5.7%	5.7%	5.8%	5.8%	5.9%	6.1%	6.3%	6.6%	7.0%
Educational Services	0.8%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%
Health Care and Social Assistance	15.6%	17.9%	18.0%	18.2%	18.4%	18.6%	18.7%	19.6%	20.5%	21.4%	23.3%
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%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.2%	7.2%
Other Services, Except Public Administration	6.5%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.4%	6.4%	6.4%
Federal Civilian Government	1.7%	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.5%	1.4%	1.2%
Federal Military	1.3%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%	0.7%
State and Local Government	15.1%	15.7%	15.6%	15.6%	15.6%	15.5%	15.5%	15.3%	15.1%	14.9%	14.4%
Total Earnings (in millions of 2005 dollars)	24,168.27	25,503.71	26,303.90	26,962.27	27,636.74	28,327.69	29,035.50	32,841.93	37,134.15	41,972.31	53,564.65
Farm	1.6%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.3%	0.3%	0.2%
Forestry, Fishing, Related Activities	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.4%
Mining	3.6%	5.4%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
Utilities	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Construction	7.5%	6.2%	6.6%	6.5%	6.4%	6.3%	6.3%	5.9%	5.5%	5.1%	4.4%
Manufacturing	5.9%	4.8%	4.9%	4.8%	4.8%	4.7%	4.6%	4.3%	4.0%	3.6%	3.1%
Wholesale Trade	4.2%	4.0%	4.1%	4.1%	4.0%	4.0%	4.0%	3.8%	3.6%	3.4%	3.1%
Retail Trade	8.8%	7.9%	8.0%	7.9%	7.9%	7.9%	7.8%	7.6%	7.4%	7.1%	6.7%
Transportation and Warehousing	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.5%	3.4%	3.4%	3.3%
Information	1.5%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Finance and Insurance	3.4%	2.9%	2.9%	2.9%	2.9%	3.0%	3.0%	3.1%	3.2%	3.3%	3.5%
Real Estate / Rental and Lease	1.4%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%
Professional and Technical Services	4.6%	3.9%	3.8%	3.8%	3.9%	3.9%	3.9%	4.1%	4.2%	4.3%	4.6%
Management	0.1%	0.3%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.4%	0.4%
Administrative and Waste Services	3.0%	3.2%	3.2%	3.3%	3.3%	3.3%	3.4%	3.5%	3.7%	3.9%	4.3%

Table 4-35. Demographic and Employment Baseline Projections for Economic Impact Area TX-1 (continued).

Educational Services	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%
Health Care and Social Assistance	14.9%	17.9%	18.0%	18.2%	18.4%	18.6%	18.8%	19.8%	20.8%	21.8%	23.8%
Arts, Entertainment, and Recreation	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
Accommodation and Food Services	3.4%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.1%	3.1%	3.1%	3.0%
Other Services, Except Public Administration	4.5%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
Federal Civilian Government	4.9%	5.6%	5.5%	5.5%	5.4%	5.4%	5.4%	5.2%	5.1%	4.9%	4.6%
Federal Military	2.8%	2.8%	2.8%	2.7%	2.7%	2.7%	2.6%	2.5%	2.4%	2.3%	2.0%
State and Local Government	17.8%	18.8%	18.7%	18.7%	18.7%	18.7%	18.8%	18.8%	18.9%	18.9%	18.8%
Total Personal Income per Capita (in 2005 dollars)	21,146	22,321	22,304	22,511	22,729	22,955	23,191	24,519	26,103	27,956	32,387
Woods & Poole Economics Wealth Index (U.S. = 100)	68.3	75.0	74.8	74.9	75.0	75.2	75.3	75.9	76.5	77.0	77.8
Persons per Household (in number of people)	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3.2
Mean Household Total Personal Income (in 2005 dollars)	69,895	79,290	79,758	80,471	81,303	82,071	82,820	87,661	93,266	100,012	116,180
Number of Households (in thousands)	499.93	548.88	560.61	573.81	586.98	600.13	613.23	677.74	740.82	801.64	914.78
Income <$10,000 (thousands of households, 2000$)	15.6%	14.2%	13.9%	13.7%	13.5%	13.3%	13.1%	12.0%	10.6%	9.0%	6.7%
Income $10,000 to $19,999	17.6%	16.0%	15.7%	15.5%	15.2%	15.0%	14.8%	13.6%	12.0%	10.2%	7.6%
Income $20,000 to $29,999	15.0%	13.8%	13.6%	13.4%	13.2%	13.0%	12.8%	11.7%	10.3%	8.8%	6.5%
Income $30,000 to $44,999	18.8%	19.9%	20.0%	20.1%	20.2%	20.3%	20.4%	20.5%	19.8%	17.5%	13.0%
Income $45,000 to $59,999	12.5%	13.7%	14.0%	14.2%	14.4%	14.6%	14.8%	16.0%	17.7%	19.7%	19.7%
Income $60,000 to $74,999	7.7%	8.5%	8.6%	8.7%	8.9%	9.0%	9.1%	9.9%	11.2%	13.1%	17.3%
Income $75,000 to $99,999	6.6%	7.2%	7.3%	7.4%	7.5%	7.7%	7.8%	8.4%	9.5%	11.1%	15.0%
Income $100,000 or more	6.1%	6.7%	6.8%	6.9%	7.1%	7.2%	7.3%	7.9%	8.9%	10.5%	14.2%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 13 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., 2010.

Table 4-36

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)	579.99	626.33	634.39	642.51	650.70	658.94	667.23	709.17	751.75	794.43	879.89
Age Under 19 years	29.7%	29.4%	29.3%	29.3%	29.2%	29.2%	29.1%	29.1%	28.9%	28.5%	27.9%
Age 20 to 34	18.6%	18.9%	19.2%	19.3%	19.4%	19.3%	19.2%	19.1%	19.0%	19.0%	19.4%
Age 35 to 49	22.5%	20.5%	20.0%	19.5%	19.1%	18.9%	18.7%	18.1%	17.9%	18.0%	18.1%
Age 50 to 64	16.8%	18.5%	18.8%	18.9%	19.1%	19.2%	19.2%	18.4%	17.2%	16.0%	15.4%
Age 65 and over	12.3%	12.6%	12.7%	13.0%	13.2%	13.5%	13.7%	15.3%	17.1%	18.5%	19.2%
Median Age of Population (in years)	39	40	40	39	39	39	39	39	39	39	39
White Population (in thousands)	58.9%	55.1%	54.5%	53.8%	53.2%	52.6%	51.9%	48.8%	45.6%	42.5%	36.5%
Black Population (in thousands)	9.1%	9.9%	10.0%	10.0%	10.1%	10.2%	10.3%	10.7%	11.2%	11.8%	12.9%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%
Asian and Pacific Islander Population (in thousands)	2.3%	3.1%	3.2%	3.2%	3.3%	3.3%	3.4%	3.5%	3.7%	3.8%	3.9%
Hispanic or Latino Population (in thousands)	29.4%	31.5%	32.0%	32.6%	33.1%	33.6%	34.1%	36.6%	39.1%	41.6%	46.2%
Male Population (in thousands)	50.4%	50.4%	50.4%	50.4%	50.4%	50.4%	50.4%	50.4%	50.4%	50.3%	50.2%
Total Employment (in thousands of jobs)	287.61	309.97	317.96	321.85	325.78	329.76	333.78	354.48	376.26	399.12	448.26
Farm Employment	7.4%	7.0%	6.9%	6.8%	6.7%	6.7%	6.6%	6.2%	5.8%	5.5%	4.8%
Forestry, Fishing, Related Activities	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%
Mining	2.4%	3.4%	3.4%	3.4%	3.3%	3.3%	3.3%	3.2%	3.0%	2.9%	2.7%
Utilities	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Construction	9.6%	7.5%	7.5%	7.6%	7.6%	7.7%	7.8%	8.0%	8.3%	8.5%	9.0%
Manufacturing	9.7%	9.2%	9.1%	9.0%	8.9%	8.8%	8.7%	8.2%	7.8%	7.3%	6.5%
Wholesale Trade	2.7%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.4%
Retail Trade	11.3%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	10.9%	10.9%	10.8%	10.7%
Transportation and Warehousing	2.9%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.1%	3.1%	3.1%	3.2%
Information Employment	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%	0.6%
Finance and Insurance	3.4%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%
Real Estate/Rental and Lease	3.4%	3.6%	3.6%	3.6%	3.6%	3.6%	3.7%	3.7%	3.8%	3.9%	4.1%
Professional and Technical Services	3.9%	4.1%	4.1%	4.1%	4.2%	4.2%	4.2%	4.4%	4.6%	4.8%	5.1%
Management	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%

Table 4-36. Demographic and Employment Baseline Projections for Economic Impact Area TX-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Administrative and Waste Services	4.6%	4.3%	4.3%	4.4%	4.4%	4.5%	4.5%	4.7%	5.0%	5.2%	5.7%
Educational Services	0.9%	1.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.5%	1.6%	1.7%	2.0%
Health Care and Social Assistance	7.7%	8.9%	8.9%	9.0%	9.1%	9.1%	9.2%	9.6%	10.0%	10.4%	11.3%
Arts, Entertainment, and Recreation	1.2%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%
Accommodation and Food Services	5.6%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.6%	5.5%	5.5%	5.3%
Other Services, Except Public Administration	6.5%	6.2%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%
Federal Civilian Government	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	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%	13.4%	13.4%	13.4%	13.4%	13.3%	13.3%	13.3%	13.2%	13.1%	12.8%
Total Earnings (in millions of 2005 dollars)	10,282.28	10,218.80	10,728.94	10,949.05	11,173.46	11,402.24	11,635.47	12,871.31	14,231.04	15,725.90	19,170.07
Farm Employment	3.5%	1.4%	1.2%	1.2%	1.2%	1.2%	1.1%	1.0%	0.9%	0.8%	0.7%
Forestry, Fishing, Related Activities	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
Mining	4.3%	6.0%	5.8%	5.8%	5.8%	5.9%	5.9%	6.1%	6.3%	6.4%	6.8%
Utilities	1.6%	1.5%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.6%	1.7%	1.8%
Construction	11.7%	9.1%	10.1%	10.1%	10.0%	10.0%	10.0%	9.8%	9.6%	9.5%	9.0%
Manufacturing	20.2%	19.4%	19.6%	19.4%	19.1%	18.9%	18.7%	17.7%	16.8%	15.8%	14.0%
Wholesale Trade	3.5%	3.8%	3.7%	3.7%	3.7%	3.7%	3.7%	3.8%	3.8%	3.8%	3.9%
Retail Trade	8.1%	7.8%	7.7%	7.7%	7.7%	7.7%	7.7%	7.6%	7.5%	7.4%	7.2%
Transportation and Warehousing	3.5%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.8%	3.8%
Information Employment	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.6%
Finance and Insurance	3.0%	3.2%	3.3%	3.3%	3.4%	3.4%	3.4%	3.5%	3.6%	3.7%	3.8%
Real Estate/Rental and Lease	1.5%	1.7%	1.6%	1.6%	1.7%	1.7%	1.7%	1.8%	1.8%	1.9%	2.1%
Professional and Technical Services	3.9%	4.1%	4.1%	4.1%	4.2%	4.2%	4.3%	4.5%	4.7%	5.0%	5.5%
Management	0.1%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%
Administrative and Waste Services	2.5%	2.6%	2.6%	2.6%	2.7%	2.7%	2.7%	2.9%	3.1%	3.3%	3.7%
Educational Services	0.5%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.9%	1.0%
Health Care and Social Assistance	7.5%	8.5%	8.6%	8.7%	8.7%	8.8%	8.9%	9.2%	9.6%	10.0%	10.8%
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	2.2%	2.5%	2.4%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%	2.2%	2.2%
Other Services, Except Public Administration	5.2%	4.9%	4.7%	4.7%	4.7%	4.7%	4.8%	4.8%	4.8%	4.8%	4.7%
Federal Civilian Government	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Federal Military	0.6%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%
State and Local Government	13.9%	15.5%	15.1%	15.1%	15.2%	15.2%	15.2%	15.4%	15.5%	15.5%	15.6%
Total Personal Income per Capita (in 2005 dollars)	29,643	30,101	30,571	30,892	31,211	31,533	31,862	33,626	35,635	37,920	43,270
Woods & Poole Economics Wealth Index (U.S. = 100)	79.0	80.7	81.0	81.2	81.4	81.6	81.8	82.8	83.8	84.8	86.9
Persons per Household (in number of people)	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.8

Table 4-36. Demographic and Employment Baseline Projections for Economic Impact Area TX-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	71,979	73,706	75,027	75,915	76,840	77,800	78,796	84,429	91,140	99,046	118,671
Total Number of Households (in thousands)	208.95	226.47	229.54	233.19	236.81	240.39	243.95	261.04	277.09	291.82	317.15
Income <$10,000 (thousands of households, 2000$)	9.6%	8.8%	8.5%	8.4%	8.2%	8.1%	7.9%	7.1%	6.3%	5.5%	4.2%
Income $10,000 to $19,999	12.9%	11.8%	11.6%	11.4%	11.2%	11.0%	10.7%	9.7%	8.7%	7.6%	5.8%
Income $20,000 to $29,999	12.9%	11.9%	11.7%	11.5%	11.3%	11.1%	10.9%	9.8%	8.9%	7.8%	6.0%
Income $30,000 to $44,999	17.5%	16.9%	16.7%	16.5%	16.3%	16.1%	15.9%	14.5%	13.1%	11.5%	8.8%
Income $45,000 to $59,999	14.4%	15.0%	15.2%	15.3%	15.4%	15.6%	15.7%	16.1%	15.7%	14.2%	10.8%
Income $60,000 to $74,999	11.3%	12.1%	12.4%	12.6%	12.8%	13.0%	13.3%	14.6%	16.1%	17.6%	17.2%
Income $75,000 to $99,999	11.0%	11.9%	12.2%	12.4%	12.6%	12.8%	13.0%	14.4%	15.9%	18.1%	24.0%
Income $100,000 or More	10.6%	11.5%	11.8%	12.0%	12.2%	12.4%	12.6%	13.9%	15.4%	17.5%	23.3%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 12 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., 2010.

Table 4-37

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)	5,552.60	6,192.43	6,299.99	6,408.25	6,517.13	6,626.68	6,736.63	7,292.42	7,855.87	8,421.37	9,556.30
Age Under 19 years	30.9%	30.8%	30.7%	30.6%	30.6%	30.5%	30.4%	30.2%	29.7%	29.4%	28.8%
Age 20 to 34	22.3%	21.8%	21.8%	21.7%	21.7%	21.6%	21.5%	21.2%	21.4%	21.2%	20.9%
Age 35 to 49	22.7%	21.2%	20.9%	20.6%	20.4%	20.3%	20.2%	19.7%	19.1%	18.9%	19.0%
Age 50 to 64	15.6%	17.1%	17.4%	17.4%	17.5%	17.5%	17.5%	16.9%	16.1%	15.6%	15.1%
Age 65 and over	8.6%	9.1%	9.3%	9.5%	9.8%	10.1%	10.4%	12.0%	13.7%	14.9%	16.2%
Median Age of Population (in years)	37	38	38	38	38	38	38	38	39	39	40
White Population (in thousands)	46.5%	43.0%	42.3%	41.7%	41.1%	40.4%	39.8%	36.8%	33.9%	31.3%	26.4%
Black Population (in thousands)	17.4%	17.4%	17.3%	17.2%	17.0%	16.9%	16.8%	16.3%	15.7%	15.1%	13.9%
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)	5.4%	5.9%	6.1%	6.2%	6.3%	6.4%	6.5%	7.1%	7.6%	8.2%	9.2%
Hispanic or Latino Population (in thousands)	30.4%	33.4%	34.0%	34.6%	35.2%	35.9%	36.5%	39.5%	42.4%	45.1%	50.0%
Male Population (in thousands)	50.0%	50.1%	50.1%	50.1%	50.0%	50.0%	50.0%	49.9%	49.8%	49.7%	49.5%
Total Employment (in thousands of jobs)	3,218.66	3,596.00	3,700.61	3,758.99	3,818.15	3,878.09	3,938.83	4,254.86	4,592.14	4,951.73	5,742.46
Farm employment	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	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%	3.5%	3.4%	3.4%	3.4%	3.3%	3.3%	3.1%	2.9%	2.8%	2.5%
Utilities	0.5%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Construction	8.0%	7.2%	7.3%	7.3%	7.3%	7.3%	7.4%	7.5%	7.6%	7.8%	8.0%
Manufacturing	7.4%	7.4%	7.3%	7.2%	7.2%	7.1%	7.0%	6.6%	6.2%	5.9%	5.2%
Wholesale trade	4.5%	4.3%	4.3%	4.3%	4.3%	4.2%	4.2%	4.2%	4.2%	4.2%	4.1%
Retail trade	10.2%	9.4%	9.4%	9.4%	9.4%	9.4%	9.4%	9.3%	9.3%	9.2%	9.0%
Transportation and Warehousing	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%	4.2%	4.2%	4.1%	4.0%
Information Employment	1.5%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%	1.0%
Finance and Insurance	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.4%	4.4%
Real Estate/Rental and Lease	4.1%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%
Professional and Technical Services	7.8%	8.0%	8.0%	8.0%	8.1%	8.1%	8.2%	8.5%	8.7%	9.0%	9.6%
Management	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%

Table 4-37. Demographic and Employment Baseline Projections for Economic Impact Area TX-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Administrative and Waste Services	7.4%	7.1%	7.1%	7.2%	7.2%	7.3%	7.3%	7.6%	7.9%	8.2%	8.8%
Educational Services	1.6%	1.7%	1.7%	1.8%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%	2.0%
Health Care and Social Assistance	8.2%	9.5%	9.5%	9.6%	9.6%	9.6%	9.7%	9.9%	10.1%	10.3%	10.8%
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%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.8%
Other Services, Except Public Administration	6.0%	5.8%	5.9%	5.9%	5.9%	5.9%	5.9%	6.0%	6.1%	6.1%	6.2%
Federal Civilian Government	1.0%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	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%	10.5%	10.5%	10.4%	10.4%	10.4%	10.4%	10.3%	10.1%	10.0%	9.7%
Total Earnings (in millions of 2005 dollars)	186,536.19	200,395.27	208,221.43	213,342.61	218,582.25	223,942.87	229,427.07	258,795.84	291,672.20	328,441.16	415,393.44
Farm employment	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	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%	13.9%	13.7%	13.8%	13.8%	13.9%	13.9%	14.2%	14.4%	14.6%	15.0%
Utilities	1.6%	2.2%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.0%
Construction	8.2%	6.8%	7.3%	7.2%	7.2%	7.1%	7.1%	6.9%	6.6%	6.4%	5.9%
Manufacturing	11.7%	11.5%	11.8%	11.7%	11.5%	11.4%	11.3%	10.6%	10.0%	9.4%	8.4%
Wholesale Trade	6.2%	6.1%	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%	6.3%	6.3%	6.3%
Retail Trade	5.2%	4.6%	4.6%	4.6%	4.6%	4.5%	4.5%	4.4%	4.3%	4.2%	4.0%
Transportation and Warehousing	5.6%	5.6%	5.6%	5.6%	5.5%	5.5%	5.5%	5.3%	5.2%	5.1%	4.8%
Information Employment	1.7%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.2%	1.2%	1.1%
Finance and Insurance	5.5%	5.2%	5.2%	5.2%	5.2%	5.2%	5.3%	5.4%	5.4%	5.5%	5.6%
Real Estate/Rental and Lease	2.4%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.6%	1.6%	1.7%
Professional and Technical Services	10.8%	10.8%	10.7%	10.8%	10.8%	10.9%	11.0%	11.4%	11.8%	12.2%	13.0%
Management	0.6%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.4%	1.5%	1.6%	1.8%
Administrative and Waste Services	4.4%	3.9%	4.0%	4.0%	4.1%	4.1%	4.1%	4.3%	4.6%	4.8%	5.2%
Educational Services	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	1.1%	1.2%
Health Care and Social Assistance	6.5%	7.2%	7.1%	7.2%	7.2%	7.2%	7.3%	7.4%	7.5%	7.7%	7.9%
Arts, Entertainment, and Recreation	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%
Accommodation and Food Services	2.3%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.1%	2.1%	2.1%
Other Services, Except Public Administration	3.1%	2.9%	2.8%	2.8%	2.8%	2.8%	2.8%	2.9%	2.9%	2.9%	2.9%
Federal Civilian Government	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%
Federal Military	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%
State and Local Government	8.3%	8.9%	8.8%	8.8%	8.8%	8.8%	8.8%	8.8%	8.8%	8.7%	8.6%
Total Personal Income per Capita (in 2005 dollars)	38,941	38,315	39,041	39,421	39,818	40,231	40,661	43,035	45,798	48,984	56,613
Woods & Poole Economics Wealth Index (U.S. = 100)	85.7	87.4	87.9	87.8	87.6	87.5	87.4	86.9	86.7	86.7	87.2
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

Table 4-37. Demographic and Employment Baseline Projections for Economic Impact Area TX-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	80,484	82,582	84,242	84,841	85,460	86,115	86,816	91,101	96,652	103,525	121,269
Total Number of Households (in thousands)	1,988.28	2,215.36	2,252.62	2,295.55	2,338.22	2,380.57	2,422.51	2,625.44	2,817.83	2,996.74	3,310.18
Income <$10,000 (thousands of households, 2000$)	8.7%	8.2%	8.0%	7.9%	7.7%	7.6%	7.4%	6.7%	6.0%	5.4%	4.2%
Income $10,000 to $19,999	11.0%	10.4%	10.1%	10.0%	9.8%	9.7%	9.5%	8.6%	7.7%	6.9%	5.5%
Income $20,000 to $29,999	12.0%	11.4%	11.1%	11.0%	10.8%	10.6%	10.4%	9.4%	8.5%	7.6%	6.0%
Income $30,000 to $44,999	16.8%	16.1%	15.8%	15.6%	15.4%	15.1%	14.8%	13.5%	12.2%	11.0%	8.7%
Income $45,000 to $59,999	14.0%	14.4%	14.5%	14.5%	14.6%	14.6%	14.6%	14.2%	13.1%	11.9%	9.4%
Income $60,000 to $74,999	10.8%	11.3%	11.5%	11.7%	11.9%	12.1%	12.3%	13.4%	14.4%	14.9%	13.3%
Income $75,000 to $99,999	11.4%	12.0%	12.3%	12.4%	12.6%	12.9%	13.1%	14.4%	16.0%	17.8%	21.5%
Income $100,000 or more	15.4%	16.3%	16.7%	16.9%	17.2%	17.5%	17.9%	19.7%	22.0%	24.6%	31.3%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 17 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., 2010.

Table 4-38

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)	334.22	334.72	336.53	338.39	340.27	342.20	344.15	354.20	364.61	375.07	396.08
Age Under 19 Years	29.2%	28.5%	28.4%	28.3%	28.3%	28.2%	28.2%	28.1%	27.8%	27.2%	26.0%
Age 20 to 34	21.8%	21.9%	21.9%	21.9%	21.7%	21.4%	20.8%	19.6%	19.1%	19.0%	19.4%
Age 35 to 49	20.9%	18.9%	18.5%	18.3%	18.1%	18.1%	18.4%	18.6%	18.9%	18.2%	17.3%
Age 50 to 64	16.2%	18.1%	18.5%	18.6%	18.8%	18.9%	19.0%	18.4%	17.1%	16.9%	17.8%
Age 65 and Over	11.9%	12.6%	12.6%	12.9%	13.2%	13.4%	13.6%	15.2%	17.1%	18.7%	19.6%
Median Age of Population (in years)	35	35	36	36	36	36	36	38	39	40	41
White Population (in thousands)	74.6%	73.9%	73.8%	73.8%	73.7%	73.6%	73.6%	73.2%	72.8%	72.3%	71.4%
Black Population (in thousands)	20.8%	20.7%	20.7%	20.7%	20.7%	20.7%	20.6%	20.5%	20.4%	20.4%	20.3%
Native American Population (in thousands)	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%
Asian and Pacific Islander Population (in thousands)	1.0%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.3%	1.4%	1.5%	1.7%
Hispanic or Latino Population (in thousands)	3.0%	3.5%	3.6%	3.7%	3.8%	3.8%	3.9%	4.3%	4.6%	5.0%	5.8%
Male Population (in thousands)	49.9%	49.8%	49.8%	49.8%	49.8%	49.8%	49.8%	49.8%	49.7%	49.7%	49.5%
Total Employment (in thousands of jobs)	171.65	177.73	182.05	183.91	185.81	187.70	189.62	199.43	209.65	220.27	242.80
Farm Employment	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.7%	1.6%	1.5%
Forestry, Fishing, Related Activities	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%
Mining	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.0%	1.0%	0.9%
Utilities	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Construction	8.7%	8.9%	9.0%	9.0%	9.0%	9.1%	9.1%	9.3%	9.4%	9.6%	9.8%
Manufacturing	6.7%	6.7%	6.6%	6.5%	6.4%	6.4%	6.3%	5.9%	5.5%	5.1%	4.5%
Wholesale Trade	2.2%	2.0%	2.0%	2.0%	1.9%	1.9%	1.9%	1.8%	1.7%	1.6%	1.5%
Retail Trade	11.0%	10.4%	10.4%	10.4%	10.4%	10.4%	10.4%	10.3%	10.3%	10.2%	10.0%
Transportation and Warehousing	3.2%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.7%	2.7%
Information Employment	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%
Finance and Insurance	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.4%	2.4%	2.3%	2.2%	2.1%
Real Estate / Rental and Lease	2.4%	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%	2.6%	2.6%	2.8%
Professional and Technical Services	4.7%	4.5%	4.5%	4.5%	4.6%	4.6%	4.7%	4.9%	5.1%	5.3%	5.8%
Management	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%

Table 4-38. Demographic and Employment Baseline Projections for Economic Impact Area LA-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Administrative and Waste Services	3.8%	4.9%	5.0%	5.0%	5.1%	5.2%	5.3%	5.8%	6.2%	6.8%	7.9%
Educational Services	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%
Health Care and Social Assistance	9.5%	10.7%	10.8%	10.9%	11.0%	11.1%	11.2%	11.8%	12.4%	12.9%	14.1%
Arts, Entertainment, and Recreation	2.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.0%
Accommodation and Food Services	7.9%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.7%	7.7%	7.7%	7.6%
Other Services, Except Public Administration	6.2%	5.8%	5.8%	5.8%	5.9%	5.9%	6.0%	6.2%	6.3%	6.5%	6.9%
Federal Civilian Government	2.1%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.8%	1.7%	1.6%	1.4%
Federal Military	5.7%	5.8%	5.8%	5.7%	5.6%	5.6%	5.5%	5.2%	4.9%	4.6%	4.1%
State and Local Government	14.0%	14.8%	14.8%	14.7%	14.6%	14.5%	14.4%	14.0%	13.6%	13.2%	12.3%
Total Earnings (in millions of 2005 dollars)	6,873.26	7,285.45	7,545.69	7,677.77	7,811.98	7,948.32	8,086.83	8,813.22	9,599.12	10,449.14	12,361.78
Farm Employment	0.5%	0.8%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	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%	2.3%	1.9%	1.9%	1.9%	1.9%	1.9%	2.0%	2.0%	2.0%	2.1%
Utilities	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Construction	7.6%	10.9%	11.8%	11.7%	11.7%	11.6%	11.6%	11.3%	11.0%	10.7%	10.0%
Manufacturing	14.6%	12.5%	12.7%	12.6%	12.4%	12.3%	12.2%	11.5%	10.8%	10.2%	8.9%
Wholesale Trade	2.7%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.3%	2.2%	2.2%	2.0%
Retail Trade	6.3%	5.6%	5.6%	5.6%	5.5%	5.5%	5.5%	5.5%	5.4%	5.4%	5.2%
Transportation and Warehousing	3.6%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.8%	2.8%	2.8%
Information Employment	2.6%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.3%	2.3%
Finance and Insurance	2.3%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Real Estate / Rental and Lease	1.2%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%	1.3%	1.4%	1.6%
Professional and Technical Services	5.4%	5.4%	5.3%	5.4%	5.5%	5.5%	5.6%	6.0%	6.3%	6.7%	7.4%
Management	1.5%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Administrative and Waste Services	2.2%	3.0%	3.0%	3.1%	3.2%	3.2%	3.3%	3.7%	4.1%	4.5%	5.5%
Educational Services	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Health Care and Social Assistance	8.7%	9.2%	9.2%	9.3%	9.4%	9.5%	9.7%	10.2%	10.8%	11.4%	12.6%
Arts, Entertainment, and Recreation	1.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
Accommodation and Food Services	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.8%
Other Services, Except Public Administration	3.7%	3.0%	3.0%	3.0%	3.1%	3.1%	3.1%	3.2%	3.3%	3.4%	3.7%
Federal Civilian Government	3.8%	4.1%	4.0%	4.0%	4.0%	4.0%	3.9%	3.9%	3.8%	3.7%	3.6%
Federal Military	10.6%	11.4%	11.3%	11.3%	11.2%	11.2%	11.2%	11.0%	10.8%	10.6%	10.1%
State and Local Government	13.8%	14.1%	13.8%	13.8%	13.8%	13.8%	13.7%	13.6%	13.4%	13.2%	12.8%
Total Personal Income per Capita (in 2005 dollars)	27,573	29,916	30,288	30,714	31,145	31,584	32,032	34,415	37,065	39,997	46,695
Woods & Poole Economics Wealth Index (U.S. = 100)	70.1	84.8	84.6	84.8	85.0	85.2	85.4	86.4	87.4	88.4	90.3
Persons per Household (in number of people)	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6

Table 4-38. Demographic and Employment Baseline Projections for Economic Impact Area LA-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Mean Household Total Personal Income (in 2005 dollars)	66,070	78,879	79,669	80,570	81,502	82,473	83,478	89,133	95,837	103,681	123,003
Total Number of Households (in thousands)	123.62	124.83	125.65	126.79	127.92	129.02	130.11	135.19	139.77	143.78	150.15
Income < $10,000 (thousands of households, 2000$)	12.1%	10.9%	10.6%	10.5%	10.3%	10.1%	9.9%	8.7%	7.5%	6.4%	4.8%
Income $10,000 to $19,999	14.8%	13.3%	13.0%	12.8%	12.6%	12.3%	12.1%	10.6%	9.2%	7.8%	5.8%
Income $20,000 to $29,999	13.0%	11.6%	11.3%	11.1%	10.9%	10.7%	10.5%	9.2%	7.9%	6.8%	5.0%
Income $30,000 to $44,999	19.5%	18.6%	18.4%	18.2%	17.9%	17.6%	17.4%	15.3%	13.2%	11.3%	8.3%
Income $45,000 to $59,999	15.2%	17.0%	17.4%	17.7%	18.0%	18.3%	18.6%	20.1%	20.1%	18.3%	13.8%
Income $60,000 to $74,999	9.6%	10.8%	11.1%	11.3%	11.5%	11.7%	11.9%	13.7%	16.0%	18.7%	20.4%
Income $75,000 to $99,999	8.9%	9.9%	10.2%	10.3%	10.5%	10.7%	10.9%	12.5%	14.7%	17.4%	23.7%
Income $100,000 or More	6.9%	7.8%	8.0%	8.1%	8.2%	8.4%	8.5%	9.7%	11.4%	13.4%	18.2%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 6 parishes 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., 2010.

Table 4-39

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)	558.39	587.88	593.59	599.38	605.23	611.14	617.10	647.47	678.54	709.79	772.62
Age Under 19 Years	29.9%	28.9%	28.8%	28.7%	28.5%	28.5%	28.4%	28.2%	27.7%	27.0%	25.6%
Age 20 to 34	21.0%	22.0%	22.1%	22.0%	21.8%	21.5%	21.0%	19.5%	18.7%	18.6%	18.8%
Age 35 to 49	21.6%	19.1%	18.7%	18.4%	18.3%	18.3%	18.5%	19.3%	20.2%	19.5%	18.0%
Age 50 to 64	15.9%	18.0%	18.4%	18.6%	18.8%	18.9%	18.9%	18.4%	16.7%	16.5%	18.4%
Age 65 and Over	11.6%	12.0%	12.1%	12.3%	12.6%	12.8%	13.1%	14.7%	16.7%	18.4%	19.1%
Median Age of Population (in years)	35	35	35	35	35	35	36	37	38	39	40
White Population (in thousands)	69.1%	68.3%	68.2%	68.1%	68.0%	67.9%	67.8%	67.2%	66.6%	66.0%	64.6%
Black Population (in thousands)	27.7%	28.0%	28.0%	28.0%	28.1%	28.1%	28.2%	28.4%	28.6%	28.8%	29.4%
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)	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.5%	1.6%	1.7%	1.9%
Hispanic or Latino Population (in thousands)	1.7%	2.2%	2.2%	2.3%	2.3%	2.4%	2.4%	2.7%	2.9%	3.2%	3.8%
Male Population (in thousands)	48.6%	48.7%	48.7%	48.7%	48.8%	48.8%	48.8%	48.9%	48.9%	48.9%	48.8%
Total Employment (in thousands of jobs)	297.51	321.93	330.21	334.03	337.89	341.78	345.70	365.76	386.61	408.21	453.71
Farm Employment	1.9%	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%	1.6%	1.5%	1.4%	1.3%
Forestry, Fishing, Related Activities	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Mining	6.9%	8.3%	8.3%	8.3%	8.2%	8.2%	8.2%	8.0%	7.8%	7.6%	7.2%
Utilities	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Construction	6.7%	6.8%	6.8%	6.8%	6.7%	6.7%	6.7%	6.5%	6.3%	6.2%	5.8%
Manufacturing	6.1%	5.9%	5.8%	5.7%	5.6%	5.6%	5.5%	5.1%	4.8%	4.4%	3.8%
Wholesale Trade	3.7%	3.6%	3.6%	3.5%	3.5%	3.5%	3.5%	3.4%	3.4%	3.3%	3.2%
Retail Trade	11.5%	11.2%	11.2%	11.2%	11.1%	11.1%	11.1%	10.9%	10.7%	10.5%	10.0%
Transportation and Warehousing	3.5%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Information Employment	1.5%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Finance and Insurance	3.4%	3.2%	3.2%	3.2%	3.2%	3.1%	3.1%	3.1%	3.0%	3.0%	2.8%

Table 4-39. Demographic and Employment Baseline Projections for Economic Impact Area LA-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Real Estate / Rental and Lease	4.0%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.3%	3.3%	3.3%	3.2%
Professional and Technical Services	4.7%	5.2%	5.2%	5.3%	5.3%	5.3%	5.4%	5.5%	5.6%	5.8%	6.0%
Management	1.1%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%
Administrative and Waste Services	4.6%	4.9%	4.9%	4.9%	4.9%	5.0%	5.0%	5.2%	5.3%	5.4%	5.7%
Educational Services	1.2%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Health Care and Social Assistance	11.2%	12.0%	12.1%	12.3%	12.5%	12.6%	12.8%	13.6%	14.4%	15.2%	17.0%
Arts, Entertainment, and Recreation	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.6%
Accommodation and Food Services	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.5%	6.5%	6.6%	6.6%
Other Services, Except Public Administration	7.0%	7.0%	7.1%	7.1%	7.2%	7.2%	7.3%	7.6%	8.0%	8.3%	9.0%
Federal Civilian Government	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%
Federal Military	0.9%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.5%
State and Local Government	10.8%	10.2%	10.2%	10.1%	10.1%	10.0%	9.9%	9.7%	9.4%	9.1%	8.6%
Total Earnings (in millions of 2005 dollars)	11,484.00	12,782.07	13,132.04	13,420.62	13,715.20	14,015.87	14,322.73	15,953.99	17,757.47	19,748.33	24,357.40
Farm Employment	0.8%	1.5%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%	1.0%	0.9%	0.8%
Forestry, Fishing, Related Activities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%
Mining	13.7%	17.7%	17.7%	17.8%	17.9%	18.0%	18.1%	18.7%	19.3%	19.9%	21.0%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Construction	7.1%	6.0%	6.3%	6.2%	6.1%	6.0%	5.9%	5.4%	4.9%	4.5%	3.8%
Manufacturing	7.5%	7.6%	7.7%	7.6%	7.5%	7.4%	7.3%	6.8%	6.3%	5.9%	5.1%
Wholesale Trade	4.7%	4.8%	5.0%	4.9%	4.9%	4.9%	4.9%	4.9%	4.8%	4.7%	4.5%
Retail Trade	7.9%	7.7%	7.8%	7.7%	7.7%	7.6%	7.5%	7.3%	7.0%	6.7%	6.2%
Transportation and Warehousing	4.6%	3.8%	3.7%	3.7%	3.7%	3.7%	3.7%	3.6%	3.6%	3.6%	3.5%
Information Employment	1.7%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%
Finance and Insurance	4.1%	2.9%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Real Estate / Rental and Lease	3.5%	2.6%	2.6%	2.6%	2.7%	2.7%	2.7%	2.7%	2.7%	2.8%	2.8%
Professional and Technical Services	6.0%	6.1%	6.1%	6.1%	6.1%	6.2%	6.2%	6.3%	6.4%	6.5%	6.7%
Management	1.6%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.6%	1.7%
Administrative and Waste Services	3.1%	2.9%	2.9%	2.9%	3.0%	3.0%	3.0%	3.1%	3.2%	3.2%	3.4%
Educational Services	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%
Health Care and Social Assistance	11.3%	11.6%	11.7%	11.8%	12.0%	12.1%	12.2%	12.9%	13.6%	14.3%	15.7%
Arts, Entertainment, and Recreation	0.6%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%

Table 4-39. Demographic and Employment Baseline Projections for Economic Impact Area LA-2 (continued).

Accommodation and Food Services	2.5%	2.6%	2.7%	2.7%	2.7%	2.6%	2.6%	2.6%	2.6%	2.6%	2.5%
Other Services, Except Public Administration	4.5%	4.1%	4.1%	4.2%	4.2%	4.2%	4.2%	4.4%	4.5%	4.7%	4.9%
Federal Civilian Government	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.0%	0.9%
Federal Military	0.9%	0.9%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%
State and Local Government	11.3%	11.3%	11.2%	11.1%	11.1%	11.1%	11.0%	10.8%	10.6%	10.4%	9.9%
Total Personal Income (in millions of 2005 dollars)											
Total Personal Income per Capita (in 2005 dollars)	28,507	30,706	30,852	31,247	31,645	32,047	32,456	34,618	37,001	39,634	45,589
Woods & Poole Economics Wealth Index (U.S. = 100)	72.7	78.6	77.7	77.7	77.8	77.8	77.8	77.8	77.7	77.7	77.5
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	2.7
Mean Household Total Personal Income (in 2005 dollars)	68,505	75,359	75,338	76,021	76,720	77,445	78,201	82,488	87,604	93,623	108,360
Total Number of Households (in thousands)	208.17	220.47	222.77	225.63	228.48	231.29	234.07	247.40	259.85	271.19	290.47
Income < $10,000 (thousands of households, 2000$)	15.9%	14.1%	13.9%	13.7%	13.4%	13.2%	13.0%	11.8%	10.4%	8.9%	6.5%
Income $10,000 to $19,999	15.2%	13.6%	13.3%	13.1%	12.9%	12.7%	12.6%	11.3%	10.0%	8.6%	6.3%
Income $20,000 to $29,999	12.9%	11.7%	11.5%	11.3%	11.2%	11.0%	10.8%	9.8%	8.7%	7.5%	5.5%
Income $30,000 to $44,999	18.2%	18.4%	18.3%	18.3%	18.2%	18.1%	18.0%	17.0%	15.5%	13.7%	9.9%
Income $45,000 to $59,999	14.1%	15.8%	16.1%	16.3%	16.5%	16.7%	17.0%	18.2%	18.8%	18.9%	16.5%
Income $60,000 to $74,999	9.1%	10.2%	10.4%	10.6%	10.7%	10.9%	11.0%	12.3%	14.0%	16.2%	19.4%
Income $75,000 to $99,999	7.4%	8.3%	8.5%	8.6%	8.8%	8.9%	9.0%	10.1%	11.5%	13.4%	18.4%
Income $100,000 or More	7.1%	7.9%	8.0%	8.2%	8.3%	8.4%	8.5%	9.6%	11.0%	12.8%	17.5%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 7 parishes 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., 2010.

Table 4-40

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)	1,039.88	1,126.87	1,140.44	1,154.15	1,167.97	1,181.91	1,195.92	1,266.99	1,339.29	1,411.83	1,557.29
Age Under 19 Years	29.7%	28.8%	28.6%	28.4%	28.3%	28.1%	28.1%	27.9%	27.6%	27.2%	26.3%
Age 20 to 34	22.4%	23.1%	23.4%	23.5%	23.5%	23.5%	23.1%	21.7%	20.6%	20.2%	20.3%
Age 35 to 49	21.4%	19.2%	18.7%	18.3%	18.0%	17.9%	17.9%	18.4%	19.4%	19.7%	18.1%
Age 50 to 64	16.2%	17.8%	18.1%	18.2%	18.3%	18.3%	18.3%	17.7%	16.3%	15.5%	17.3%
Age 65 and over	10.3%	11.1%	11.3%	11.6%	11.9%	12.2%	12.5%	14.3%	16.1%	17.5%	18.0%
Median Age of Population (in years)	35	35	35	35	35	36	36	37	38	39	40
White Population (in thousands)	65.7%	64.0%	63.7%	63.5%	63.3%	63.1%	62.9%	61.8%	60.7%	59.6%	57.2%
Black Population (in thousands)	29.6%	30.6%	30.7%	30.8%	30.9%	31.0%	31.1%	31.6%	32.0%	32.5%	33.4%
Native American Population (in thousands)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	1.1%	1.1%
Asian and Pacific Islander Population (in thousands)	1.4%	1.4%	1.5%	1.5%	1.5%	1.5%	1.5%	1.6%	1.7%	1.8%	2.0%
Hispanic or Latino Population (in thousands)	2.3%	3.0%	3.1%	3.2%	3.3%	3.4%	3.5%	3.9%	4.4%	5.0%	6.2%
Male Population (in thousands)	48.7%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.9%	48.8%	48.9%
Total Employment (in thousands of jobs)	606.81	663.02	680.63	689.17	697.80	706.51	715.33	760.83	808.81	859.36	968.53
Farm Employment	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
Forestry, Fishing, Related Activities	0.8%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Mining	1.5%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.7%	1.6%	1.5%	1.2%
Utilities	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
Construction	9.8%	9.3%	9.3%	9.3%	9.4%	9.4%	9.5%	9.6%	9.8%	10.0%	10.3%
Manufacturing	6.8%	6.1%	6.1%	6.0%	5.9%	5.8%	5.7%	5.3%	5.0%	4.6%	4.0%
Wholesale Trade	3.2%	2.8%	2.8%	2.8%	2.8%	2.7%	2.7%	2.6%	2.4%	2.3%	2.1%
Retail Trade	10.9%	10.1%	10.0%	10.0%	10.0%	10.0%	10.0%	9.9%	9.7%	9.6%	9.3%
Transportation and Warehousing	4.4%	4.6%	4.5%	4.5%	4.5%	4.5%	4.5%	4.4%	4.3%	4.3%	4.1%
Information Employment	1.4%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.1%	1.0%
Finance and Insurance	3.5%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.2%	3.1%	3.1%	2.9%

Table 4-40. Demographic and Employment Baseline Projections for Economic Impact Area LA-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Real Estate / Rental and Lease	3.6%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.8%	3.8%	3.8%	3.8%
Professional and Technical Services	4.8%	5.6%	5.6%	5.7%	5.7%	5.7%	5.8%	6.0%	6.1%	6.3%	6.6%
Management	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
Administrative and Waste Services	5.8%	6.1%	6.1%	6.2%	6.3%	6.4%	6.5%	7.1%	7.6%	8.2%	9.4%
Educational Services	1.1%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.6%	1.7%	1.9%	2.1%
Health Care and Social Assistance	8.8%	10.0%	10.1%	10.1%	10.2%	10.3%	10.3%	10.6%	10.9%	11.2%	11.7%
Arts, Entertainment, and Recreation	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%
Accommodation and Food Services	6.6%	6.7%	6.7%	6.8%	6.8%	6.8%	6.8%	6.9%	7.0%	7.1%	7.3%
Other Services, Except Public Administration	6.7%	6.6%	6.7%	6.7%	6.7%	6.8%	6.8%	7.0%	7.2%	7.4%	7.8%
Federal Civilian Government	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%
Federal Military	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.5%
State and Local Government	15.6%	15.0%	14.9%	14.8%	14.7%	14.5%	14.4%	13.8%	13.3%	12.7%	11.6%
Total Earnings (in millions of 2005 dollars)	24,055.56	27,529.09	28,679.63	29,248.86	29,828.55	30,418.91	31,020.09	34,194.93	37,669.23	41,468.73	50,154.87
Farm Employment	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
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	2.6%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%
Utilities	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Construction	10.3%	11.0%	12.0%	11.9%	11.9%	11.8%	11.7%	11.4%	11.1%	10.8%	10.1%
Manufacturing	12.4%	11.2%	11.3%	11.2%	11.1%	10.9%	10.8%	10.1%	9.5%	8.9%	7.7%
Wholesale Trade	4.4%	3.7%	3.8%	3.7%	3.7%	3.7%	3.7%	3.6%	3.5%	3.4%	3.2%
Retail Trade	7.2%	6.4%	6.4%	6.3%	6.3%	6.3%	6.3%	6.2%	6.1%	6.0%	5.8%
Transportation and Warehousing	6.0%	6.7%	6.7%	6.7%	6.7%	6.6%	6.6%	6.6%	6.5%	6.4%	6.3%
Information Employment	1.7%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Finance and Insurance	4.3%	3.6%	3.5%	3.5%	3.5%	3.5%	3.5%	3.6%	3.7%	3.8%	4.0%
Real Estate / Rental and Lease	2.1%	1.8%	1.7%	1.7%	1.7%	1.8%	1.8%	1.8%	1.9%	2.0%	2.1%
Professional and Technical Services	6.0%	6.9%	6.8%	6.9%	6.9%	7.0%	7.0%	7.3%	7.6%	7.9%	8.4%
Management	1.4%	1.9%	1.9%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Administrative and Waste Services	3.5%	3.9%	3.8%	3.9%	4.0%	4.1%	4.2%	4.7%	5.2%	5.7%	7.0%
Educational Services	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	1.0%
Health Care and Social Assistance	9.2%	9.4%	9.3%	9.3%	9.4%	9.5%	9.6%	9.9%	10.3%	10.6%	11.2%

Table 4-40. 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	0.7%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%
Accommodation and Food Services	2.7%	2.6%	2.5%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.7%	2.7%
Other Services, Except Public Administration	4.1%	3.6%	3.5%	3.5%	3.6%	3.6%	3.6%	3.7%	3.8%	3.9%	4.1%
Federal Civilian Government	1.2%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.6%	1.6%	1.7%
Federal Military	0.9%	0.9%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
State and Local Government	17.5%	17.8%	17.4%	17.3%	17.3%	17.2%	17.2%	16.9%	16.6%	16.3%	15.6%
Total Personal Income per Capita (in 2005 dollars)	30,731	32,203	32,690	33,093	33,505	33,924	34,352	36,628	39,151	41,951	48,338
Woods & Poole Economics Wealth Index (U.S. = 100)	79.2	85.3	85.7	85.7	85.8	85.9	86.0	86.4	86.8	87.2	88.0
Persons per Household (in number of people)	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6
Mean Household Total Personal Income (in 2005 dollars)	77,923	83,219	84,664	85,438	86,256	87,115	88,016	93,155	99,279	106,460	124,061
Total Number of Households (in thousands)	385.14	421.32	426.92	433.61	440.27	446.88	453.43	485.13	515.26	543.37	593.15
Income < $10,000 (thousands of households, 2000$)	12.4%	11.3%	11.1%	10.9%	10.7%	10.6%	10.4%	9.3%	8.2%	7.1%	5.3%
Income $10,000 to $19,999	13.2%	12.1%	11.8%	11.7%	11.5%	11.3%	11.1%	10.0%	8.8%	7.6%	5.7%
Income $20,000 to $29,999	12.1%	11.1%	10.8%	10.7%	10.5%	10.4%	10.2%	9.2%	8.1%	7.0%	5.2%
Income $30,000 to $44,999	17.5%	16.6%	16.3%	16.1%	15.9%	15.7%	15.5%	14.1%	12.4%	10.8%	8.0%
Income $45,000 to $59,999	14.7%	16.0%	16.3%	16.5%	16.7%	16.9%	17.0%	17.3%	16.7%	15.3%	11.7%
Income $60,000 to $74,999	11.1%	12.1%	12.4%	12.7%	12.9%	13.1%	13.3%	15.0%	17.1%	19.0%	19.1%
Income $75,000 to $99,999	10.0%	10.9%	11.1%	11.3%	11.5%	11.7%	11.9%	13.3%	15.3%	17.7%	24.2%
Income $100,000 or More	9.1%	9.8%	10.0%	10.1%	10.3%	10.4%	10.6%	11.8%	13.4%	15.4%	20.8%

Notes: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 10 parishes 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., 2010.

Table 4-41

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)	1,378.12	1,267.52	1,278.34	1,289.31	1,300.40	1,311.64	1,322.96	1,380.77	1,439.98	1,499.47	1,618.89
Age Under 19 Years	28.1%	26.3%	26.2%	26.1%	26.1%	26.1%	26.1%	26.5%	26.3%	25.9%	25.1%
Age 20 to 34	20.7%	20.7%	20.6%	20.5%	20.4%	20.1%	19.9%	18.1%	17.4%	17.5%	18.6%
Age 35 to 49	22.0%	20.1%	19.7%	19.4%	19.2%	19.0%	18.8%	19.1%	19.5%	19.0%	17.2%
Age 50 to 64	17.5%	20.5%	20.8%	20.9%	20.9%	21.0%	20.9%	19.8%	18.0%	17.2%	18.4%
Age 65 and Over	11.6%	12.5%	12.7%	13.1%	13.4%	13.8%	14.2%	16.5%	18.8%	20.3%	20.7%
Median Age of Population (in years)	36	36	37	37	37	37	37	38	39	40	41
White Population (in thousands)	54.4%	55.5%	55.3%	55.1%	54.9%	54.8%	54.6%	53.7%	52.8%	51.9%	50.1%
Black Population (in thousands)	37.7%	35.0%	35.0%	35.0%	35.0%	35.1%	35.1%	35.2%	35.3%	35.3%	35.4%
Native American Population (in thousands)	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Asian and Pacific Islander Population (in thousands)	2.4%	2.7%	2.7%	2.8%	2.8%	2.8%	2.9%	3.1%	3.3%	3.5%	3.7%
Hispanic or Latino Population (in thousands)	5.1%	6.4%	6.5%	6.6%	6.7%	6.9%	7.0%	7.5%	8.1%	8.8%	10.2%
Male Population (in thousands)	48.0%	48.2%	48.2%	48.2%	48.2%	48.2%	48.2%	48.2%	48.2%	48.1%	48.2%
Total Employment (in thousands of jobs)	740.50	728.32	745.53	752.64	759.77	766.93	774.11	810.24	846.71	883.43	957.04
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%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Mining	1.3%	1.5%	1.4%	1.4%	1.4%	1.3%	1.3%	1.2%	1.1%	1.0%	0.8%
Utilities	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Construction	6.2%	7.4%	7.4%	7.5%	7.6%	7.6%	7.7%	8.1%	8.5%	8.9%	9.8%
Manufacturing	5.6%	5.6%	5.5%	5.5%	5.4%	5.3%	5.3%	4.9%	4.6%	4.4%	3.8%
Wholesale Trade	3.6%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.0%	3.0%	2.9%	2.8%
Retail Trade	10.0%	10.2%	10.2%	10.3%	10.3%	10.3%	10.3%	10.5%	10.6%	10.7%	10.9%
Transportation and Warehousing	4.1%	3.8%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.6%	3.6%	3.4%
Information Employment	1.6%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.2%
Finance and Insurance	3.9%	3.5%	3.5%	3.4%	3.4%	3.4%	3.4%	3.3%	3.2%	3.1%	2.9%

Table 4-41. Demographic and Employment Baseline Projections for Economic Impact Area LA-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Real Estate / Rental and Lease	4.0%	3.9%	3.9%	3.9%	3.9%	4.0%	4.0%	4.0%	4.0%	4.1%	4.1%
Professional and Technical Services	5.7%	6.3%	6.3%	6.3%	6.2%	6.2%	6.2%	6.2%	6.1%	6.1%	5.9%
Management	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	0.9%
Administrative and Waste Services	6.4%	6.1%	6.2%	6.2%	6.3%	6.3%	6.3%	6.5%	6.7%	6.8%	7.1%
Educational Services	3.1%	3.2%	3.2%	3.2%	3.2%	3.1%	3.1%	3.1%	3.0%	3.0%	2.8%
Health Care and Social Assistance	8.8%	9.6%	9.7%	9.7%	9.8%	9.8%	9.9%	10.1%	10.4%	10.7%	11.1%
Arts, Entertainment, and Recreation	2.5%	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%	2.6%	2.6%	2.7%
Accommodation and Food Services	8.8%	9.1%	9.0%	8.9%	8.9%	8.8%	8.8%	8.4%	8.1%	7.8%	7.3%
Other Services, Except Public Administration	6.5%	6.3%	6.4%	6.4%	6.4%	6.4%	6.5%	6.6%	6.8%	6.9%	7.1%
Federal Civilian Government	2.1%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.5%	1.4%	1.3%
Federal Military	1.4%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
State and Local Government	11.9%	11.7%	11.7%	11.7%	11.8%	11.8%	11.8%	11.9%	11.9%	11.9%	12.0%
Total Earnings (in millions of 2005 dollars)	33,666.07	33,632.01	34,709.10	35,337.46	35,974.63	36,620.67	37,275.64	40,686.08	44,326.90	48,203.33	56,678.49
Farm Employment	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%	4.9%	4.8%	4.8%	4.8%	4.7%	4.7%	4.6%	4.5%	4.4%	4.1%
Utilities	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%
Construction	6.5%	6.2%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.6%
Manufacturing	8.6%	9.0%	9.2%	9.1%	9.0%	8.9%	8.8%	8.2%	7.8%	7.3%	6.5%
Wholesale Trade	5.3%	4.9%	5.0%	5.0%	5.0%	5.0%	5.0%	4.9%	4.9%	4.9%	4.8%
Retail Trade	6.2%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%
Transportation and Warehousing	5.1%	4.9%	4.8%	4.8%	4.8%	4.7%	4.7%	4.6%	4.5%	4.4%	4.2%
Information Employment	1.7%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%
Finance and Insurance	5.1%	4.2%	4.2%	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%
Real Estate / Rental and Lease	2.6%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%	1.4%
Professional and Technical Services	8.0%	9.0%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.8%	8.8%
Management	1.8%	1.7%	1.6%	1.6%	1.6%	1.7%	1.7%	1.7%	1.7%	1.8%	1.8%
Administrative and Waste Services	4.0%	3.9%	4.0%	4.1%	4.1%	4.1%	4.2%	4.4%	4.6%	4.8%	5.1%
Educational Services	2.2%	2.5%	2.5%	2.5%	2.5%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%
Health Care and Social Assistance	8.7%	9.8%	9.7%	9.8%	9.9%	9.9%	10.0%	10.3%	10.6%	10.9%	11.6%
Arts, Entertainment, and Recreation	2.1%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.1%	2.1%	2.2%	2.2%

Table 4-41. Demographic and Employment Baseline Projections for Economic Impact Area LA-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Accommodation and Food Services	4.4%	4.8%	4.7%	4.6%	4.6%	4.6%	4.5%	4.3%	4.2%	4.0%	3.7%
Other Services, Except Public Administration	3.7%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.7%	3.8%	3.9%	4.0%
Federal Civilian Government	4.2%	4.0%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%	3.8%
Federal Military	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
State and Local Government	12.1%	13.0%	12.9%	12.9%	13.0%	13.0%	13.1%	13.4%	13.7%	14.0%	14.5%
Total Personal Income per Capita (in 2005 dollars)	32,677	35,414	35,829	36,225	36,628	37,038	37,456	39,644	42,012	44,580	50,228
Woods & Poole Economics Wealth Index (U.S. = 100)	79.1	91.9	91.0	90.8	90.7	90.5	90.4	89.9	89.4	88.9	87.7
Persons per Household (in number of people)	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5
Mean Household Total Personal Income (in 2005 dollars)	77,994	87,207	87,276	87,772	88,333	88,946	89,614	93,616	98,555	104,400	118,602
Total Number of Households (in thousands)	530.24	491.36	496.01	501.93	507.80	513.61	519.34	546.73	572.34	595.76	635.83
Income < $10,000 (thousands of households, 2000$)	12.7%	10.8%	10.6%	10.5%	10.3%	10.1%	9.9%	9.2%	8.2%	7.2%	5.5%
Income $10,000 to $19,999	13.5%	11.9%	11.7%	11.5%	11.3%	11.1%	10.9%	10.1%	9.1%	8.0%	6.2%
Income $20,000 to $29,999	12.9%	11.4%	11.2%	11.1%	10.9%	10.8%	10.6%	9.7%	8.7%	7.8%	6.1%
Income $30,000 to $44,999	17.6%	15.5%	15.3%	15.2%	15.0%	14.8%	14.6%	13.6%	12.2%	10.8%	8.4%
Income $45,000 to $59,999	13.7%	15.1%	15.3%	15.4%	15.5%	15.6%	15.7%	15.5%	14.9%	14.0%	11.2%
Income $60,000 to $74,999	10.1%	11.7%	11.9%	12.0%	12.2%	12.4%	12.6%	13.8%	15.2%	16.2%	15.7%
Income $75,000 to $99,999	9.3%	11.3%	11.5%	11.7%	11.9%	12.1%	12.3%	13.6%	15.3%	17.4%	22.5%
Income $100,000 or more	10.2%	12.3%	12.5%	12.6%	12.8%	13.1%	13.3%	14.5%	16.4%	18.6%	24.3%

Notes: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 9 parishes 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., 2010.

Table 4-42

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)	476.88	470.61	474.64	478.72	482.85	487.02	491.23	512.71	534.70	556.77	601.05
Age Under 19 years	28.6%	28.0%	27.9%	27.8%	27.6%	27.6%	27.5%	27.5%	27.3%	26.8%	25.7%
Age 20 to 34	20.2%	20.3%	20.4%	20.5%	20.6%	20.5%	20.2%	19.6%	18.7%	18.5%	19.0%
Age 35 to 49	21.7%	19.8%	19.4%	19.1%	18.8%	18.5%	18.5%	18.3%	18.9%	19.0%	18.0%
Age 50 to 64	17.4%	19.0%	19.3%	19.3%	19.3%	19.4%	19.5%	18.9%	17.6%	16.8%	17.7%
Age 65 and over	12.1%	12.8%	13.0%	13.4%	13.7%	14.0%	14.3%	15.7%	17.5%	18.9%	19.6%
Median Age of Population (in years)	36	36	36	36	37	37	37	37	38	39	40
White Population (in thousands)	75.5%	74.0%	73.8%	73.7%	73.5%	73.4%	73.2%	72.5%	71.8%	71.1%	70.0%
Black Population (in thousands)	19.2%	19.8%	19.8%	19.9%	19.9%	19.9%	20.0%	20.3%	20.5%	20.8%	21.3%
Native American Population (in thousands)	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%
Asian and Pacific Islander Population (in thousands)	2.0%	2.1%	2.1%	2.2%	2.2%	2.2%	2.2%	2.3%	2.3%	2.3%	2.3%
Hispanic or Latino Population (in thousands)	2.8%	3.6%	3.7%	3.8%	3.8%	3.9%	4.0%	4.4%	4.8%	5.2%	5.9%
Male Population (in thousands)	49.6%	49.6%	49.6%	49.6%	49.6%	49.5%	49.5%	49.5%	49.6%	49.6%	49.6%
Total Employment (in thousands of jobs)	238.83	243.91	249.36	251.56	253.76	255.98	258.22	269.62	281.38	293.52	318.92
Farm Employment	1.4%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%	1.1%	1.0%	0.9%
Forestry, Fishing, Related Activities	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%
Mining	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Utilities	0.9%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Construction	7.5%	7.2%	7.2%	7.2%	7.2%	7.3%	7.3%	7.4%	7.5%	7.7%	7.9%
Manufacturing	9.5%	10.2%	10.2%	10.1%	10.0%	9.9%	9.8%	9.4%	9.0%	8.6%	7.9%
Wholesale Trade	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.2%	1.1%
Retail Trade	10.9%	10.2%	10.1%	10.1%	10.1%	10.1%	10.0%	9.9%	9.8%	9.7%	9.4%
Transportation and Warehousing	2.4%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.6%	2.6%	2.6%
Information Employment	1.4%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.1%
Finance and Insurance	2.5%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%
Real Estate / Rental and Lease	3.1%	3.5%	3.5%	3.5%	3.6%	3.6%	3.6%	3.8%	3.9%	4.0%	4.3%
Professional and Technical Services	3.8%	4.1%	4.2%	4.2%	4.2%	4.3%	4.3%	4.5%	4.8%	5.0%	5.4%
Management	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%

Table 4-42. Demographic and Employment Baseline Projections for Economic Impact Area MS-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Administrative and Waste Services	5.4%	6.0%	6.1%	6.1%	6.2%	6.3%	6.4%	6.8%	7.2%	7.6%	8.4%
Educational Services	0.5%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	1.0%	1.1%	1.2%	1.4%
Health Care and Social Assistance	6.2%	6.8%	6.9%	6.9%	6.9%	7.0%	7.0%	7.1%	7.2%	7.3%	7.5%
Arts, Entertainment, and Recreation	2.2%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
Accommodation and Food Services	12.1%	10.3%	10.3%	10.3%	10.2%	10.2%	10.2%	10.0%	9.8%	9.6%	9.3%
Other Services, Except Public Administration	5.5%	5.5%	5.6%	5.6%	5.6%	5.7%	5.7%	5.9%	6.1%	6.3%	6.7%
Federal Civilian Government	3.9%	4.0%	4.0%	3.9%	3.9%	3.9%	3.8%	3.7%	3.5%	3.4%	3.1%
Federal Military	5.7%	5.3%	5.3%	5.2%	5.2%	5.1%	5.1%	4.8%	4.6%	4.3%	3.9%
State and Local Government	12.3%	13.4%	13.4%	13.4%	13.4%	13.4%	13.3%	13.3%	13.2%	13.1%	13.0%
Total Earnings (in millions of 2005 dollars)	9,318.99	9,816.16	10,180.77	10,354.51	10,530.94	10,710.09	10,892.03	11,844.59	12,872.19	13,979.85	16,456.60
Farm Employment	0.3%	0.0%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%
Mining	0.2%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Utilities	2.1%	1.6%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.8%	1.9%	2.0%
Construction	6.0%	5.4%	6.0%	6.0%	5.9%	5.9%	5.8%	5.7%	5.5%	5.3%	5.0%
Manufacturing	15.4%	17.3%	17.7%	17.5%	17.4%	17.3%	17.1%	16.5%	15.8%	15.1%	13.9%
Wholesale Trade	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%	1.3%
Retail Trade	7.0%	6.1%	6.1%	6.0%	6.0%	6.0%	5.9%	5.8%	5.7%	5.5%	5.3%
Transportation and Warehousing	2.3%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Information Employment	1.4%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	1.0%	1.1%
Finance and Insurance	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.3%	2.4%	2.5%	2.6%
Real Estate / Rental and Lease	1.0%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	1.0%	1.1%
Professional and Technical Services	4.6%	5.1%	5.1%	5.2%	5.3%	5.3%	5.4%	5.7%	6.0%	6.3%	6.9%
Management	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Administrative and Waste Services	3.1%	3.4%	3.4%	3.5%	3.5%	3.6%	3.6%	3.9%	4.2%	4.5%	5.2%
Educational Services	0.3%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	0.7%	0.9%
Health Care and Social Assistance	6.7%	6.9%	6.9%	6.9%	6.9%	7.0%	7.0%	7.1%	7.3%	7.4%	7.6%
Arts, Entertainment, and Recreation	1.5%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	0.9%
Accommodation and Food Services	8.0%	5.9%	5.8%	5.8%	5.7%	5.7%	5.7%	5.6%	5.4%	5.3%	5.1%
Other Services, Except Public Administration	3.4%	3.5%	3.4%	3.4%	3.5%	3.5%	3.5%	3.6%	3.8%	3.9%	4.1%
Federal Civilian Government	8.4%	8.8%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.5%	8.5%	8.4%
Federal Military	10.2%	10.2%	10.1%	10.0%	10.0%	10.0%	9.9%	9.8%	9.6%	9.5%	9.2%
State and Local Government	13.2%	15.3%	15.0%	15.0%	15.1%	15.1%	15.2%	15.4%	15.5%	15.7%	16.1%
Total Personal Income per Capita (in 2005 dollars)	27,815	29,510	29,900	30,216	30,539	30,868	31,204	32,989	34,961	37,140	42,045
Woods & Poole Economics Wealth Index (U.S. = 100)	68.6	73.6	73.5	73.4	73.4	73.3	73.2	72.8	72.4	72.0	71.2
Persons per Household (in number of people)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.6

Table 4-42. 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)	65,960	67,129	67,940	68,417	68,918	69,445	70,003	73,247	77,212	81,941	93,603
Total Number of Households (in thousands)	180.00	179.76	181.51	183.72	185.92	188.09	190.24	200.49	210.03	218.68	233.44
Income < $10,000 (thousands of households, 2000$)	10.8%	9.8%	9.7%	9.5%	9.4%	9.2%	9.1%	8.4%	7.4%	6.4%	4.6%
Income $10,000 to $19,999	122.2%	122.3%	122.3%	122.3%	122.3%	122.3%	122.3%	122.5%	122.6%	122.8%	122.9%
Income $20,000 to $29,999	103.6%	102.5%	102.4%	102.4%	102.4%	102.4%	102.4%	101.9%	101.3%	101.1%	100.9%
Income $30,000 to $44,999	148.8%	154.6%	155.9%	156.8%	157.6%	158.3%	158.9%	161.1%	162.6%	163.1%	163.2%
Income $45,000 to $59,999	79.1%	92.0%	94.5%	96.5%	98.6%	100.9%	103.3%	115.9%	132.2%	147.5%	162.6%
Income $60,000 to $74,999	65.2%	66.6%	66.8%	66.9%	67.1%	67.3%	67.4%	71.0%	80.1%	94.1%	134.9%
Income $75,000 to $99,999	83.1%	82.9%	82.9%	82.9%	82.9%	82.8%	82.8%	82.7%	82.7%	84.6%	103.1%
Income $100,000 or More	81.1%	81.1%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.0%	81.1%

Notes: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 7 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., 2010.

Table 4-43

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)	691.71	725.48	731.11	736.83	742.62	748.49	754.41	784.68	815.74	846.94	909.54
Age Under 19 Years	28.1%	27.4%	27.2%	27.1%	26.9%	26.8%	26.7%	26.5%	26.1%	25.6%	24.6%
Age 20 to 34	19.2%	19.5%	19.6%	19.6%	19.5%	19.3%	19.1%	18.3%	17.7%	17.3%	17.6%
Age 35 to 49	21.1%	19.3%	18.9%	18.6%	18.5%	18.4%	18.4%	18.5%	18.8%	18.6%	17.8%
Age 50 to 64	18.0%	19.5%	19.7%	19.8%	19.8%	19.8%	19.8%	19.0%	17.6%	17.1%	17.9%
Age 65 and over	13.6%	14.4%	14.6%	14.9%	15.3%	15.6%	16.0%	17.7%	19.8%	21.3%	22.1%
Median Age of Population (in years)	38	39	39	40	40	40	40	41	42	42	44
White Population (in thousands)	66.6%	66.0%	65.9%	65.9%	65.8%	65.7%	65.7%	65.3%	64.9%	64.4%	63.7%
Black Population (in thousands)	29.6%	29.4%	29.4%	29.4%	29.3%	29.3%	29.3%	29.3%	29.3%	29.3%	29.1%
Native American Population (in thousands)	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%
Asian and Pacific Islander Population (in thousands)	1.2%	1.5%	1.5%	1.5%	1.6%	1.6%	1.6%	1.7%	1.9%	2.0%	2.3%
Hispanic or Latino Population (in thousands)	1.6%	2.2%	2.3%	2.3%	2.4%	2.4%	2.5%	2.7%	3.0%	3.3%	4.0%
Male Population (in thousands)	48.2%	48.3%	48.3%	48.3%	48.3%	48.3%	48.4%	48.4%	48.5%	48.5%	48.6%
Total Employment (in thousands of jobs)	363.84	353.63	362.59	366.69	370.81	374.97	379.15	400.55	422.75	445.72	493.98
Farm Employment	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.2%	1.2%	1.1%
Forestry, Fishing, Related Activities	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.8%	0.8%
Mining	0.3%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Utilities	0.4%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Construction	8.5%	7.5%	7.6%	7.6%	7.6%	7.6%	7.6%	7.7%	7.7%	7.7%	7.8%
Manufacturing	8.7%	7.6%	7.6%	7.5%	7.4%	7.3%	7.2%	6.9%	6.5%	6.2%	5.5%
Wholesale Trade	3.5%	3.1%	3.0%	3.0%	3.0%	3.0%	2.9%	2.8%	2.7%	2.6%	2.4%
Retail Trade	12.4%	11.9%	11.8%	11.8%	11.7%	11.6%	11.5%	11.1%	10.7%	10.3%	9.5%
Transportation and Warehousing	3.7%	3.9%	3.9%	3.8%	3.8%	3.8%	3.8%	3.6%	3.5%	3.4%	3.2%
Information Employment	1.3%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%
Finance and Insurance	3.4%	3.7%	3.7%	3.7%	3.7%	3.6%	3.6%	3.5%	3.4%	3.2%	3.0%
Real Estate / Rental and Lease	4.4%	4.6%	4.7%	4.7%	4.7%	4.7%	4.8%	4.9%	5.0%	5.2%	5.4%
Professional and Technical Services	4.4%	4.6%	4.7%	4.7%	4.7%	4.8%	4.8%	5.0%	5.2%	5.4%	5.7%
Management	0.2%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%

Table 4-43. Demographic and Employment Baseline Projections for Economic Impact Area AL-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Administrative and Waste Services	6.4%	6.4%	6.5%	6.5%	6.6%	6.7%	6.7%	7.0%	7.3%	7.6%	8.3%
Educational Services	1.4%	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.8%	1.9%	2.0%	2.2%
Health Care and Social Assistance	8.5%	9.4%	9.4%	9.5%	9.6%	9.6%	9.7%	10.1%	10.4%	10.7%	11.4%
Arts, Entertainment, and Recreation	1.3%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Accommodation and Food Services	6.8%	7.6%	7.6%	7.7%	7.7%	7.7%	7.8%	8.0%	8.2%	8.4%	8.9%
Other Services, Except Public Administration	7.7%	7.9%	7.9%	8.0%	8.0%	8.1%	8.1%	8.4%	8.7%	8.9%	9.4%
Federal Civilian Government	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%
Federal Military	1.3%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	0.9%	0.8%	0.7%
State and Local Government	12.0%	12.0%	12.0%	11.9%	11.9%	11.9%	11.8%	11.6%	11.4%	11.1%	10.7%
Total Earnings (in millions of 2005 dollars)	12,930.79	13,040.20	13,381.74	13,639.05	13,900.74	14,166.88	14,437.55	15,860.94	17,407.25	19,085.19	22,872.66
Farm Employment	0.8%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.4%
Forestry, Fishing, Related Activities	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%
Mining	0.4%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.8%
Utilities	1.0%	1.4%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.2%
Construction	8.9%	7.9%	8.6%	8.5%	8.4%	8.4%	8.3%	8.0%	7.7%	7.4%	6.8%
Manufacturing	13.6%	12.2%	12.6%	12.5%	12.4%	12.3%	12.2%	11.7%	11.2%	10.7%	9.8%
Wholesale Trade	5.1%	4.6%	4.7%	4.7%	4.6%	4.6%	4.6%	4.5%	4.4%	4.3%	4.0%
Retail Trade	8.9%	8.4%	8.5%	8.4%	8.3%	8.3%	8.2%	7.9%	7.5%	7.2%	6.5%
Transportation and Warehousing	4.8%	5.7%	5.6%	5.6%	5.6%	5.5%	5.5%	5.3%	5.1%	4.9%	4.6%
Information Employment	1.6%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%
Finance and Insurance	4.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%
Real Estate / Rental and Lease	2.3%	1.7%	1.8%	1.8%	1.8%	1.8%	1.8%	2.0%	2.1%	2.2%	2.5%
Professional and Technical Services	5.5%	6.1%	6.1%	6.2%	6.2%	6.3%	6.4%	6.7%	7.0%	7.3%	7.9%
Management	0.3%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.8%
Administrative and Waste Services	3.7%	3.6%	3.7%	3.7%	3.7%	3.8%	3.8%	4.1%	4.3%	4.6%	5.1%
Educational Services	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	1.2%	1.3%
Health Care and Social Assistance	9.8%	11.0%	11.1%	11.2%	11.3%	11.4%	11.5%	11.9%	12.4%	12.9%	13.8%
Arts, Entertainment, and Recreation	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Accommodation and Food Services	3.2%	3.5%	3.5%	3.5%	3.5%	3.6%	3.6%	3.7%	3.7%	3.8%	4.0%
Other Services, Except Public Administration	4.8%	4.9%	4.9%	4.9%	4.9%	5.0%	5.0%	5.2%	5.4%	5.5%	5.8%
Federal Civilian Government	2.2%	2.5%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Federal Military	1.8%	1.8%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%
State and Local Government	13.8%	15.2%	15.1%	15.1%	15.1%	15.1%	15.2%	15.2%	15.2%	15.2%	15.1%
Total Personal Income per Capita (in 2005 dollars)	26,961	28,132	28,252	28,605	28,964	29,329	29,701	31,665	33,826	36,202	41,511
Woods & Poole Economics Wealth Index (U.S. = 100)	69.0	71.9	71.2	71.2	71.3	71.3	71.4	71.6	71.8	72.0	72.2
Persons per Household (in number of people)	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table 4-43. 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)	61,397	63,756	63,690	64,304	64,944	65,612	66,308	70,242	74,885	80,263	93,095
Total Number of Households (in thousands)	267.98	283.15	285.62	288.82	292.00	295.14	298.23	312.96	326.65	339.07	360.09
Income < $10,000 (thousands of households, 2000$)	13.3%	11.9%	11.7%	11.6%	11.4%	11.2%	11.0%	10.0%	8.6%	7.4%	5.4%
Income $10,000 to $19,999	14.5%	13.2%	13.0%	12.8%	12.7%	12.5%	12.3%	11.2%	9.7%	8.3%	6.2%
Income $20,000 to $29,999	13.0%	11.9%	11.8%	11.6%	11.5%	11.3%	11.2%	10.2%	8.9%	7.7%	5.7%
Income $30,000 to $44,999	18.8%	18.5%	18.4%	18.2%	18.1%	17.9%	17.8%	16.5%	14.6%	12.6%	9.4%
Income $45,000 to $59,999	14.8%	16.4%	16.6%	16.8%	17.0%	17.2%	17.4%	18.7%	19.5%	18.8%	14.8%
Income $60,000 to $74,999	9.6%	10.6%	10.7%	10.9%	11.0%	11.2%	11.3%	12.5%	14.4%	16.8%	19.9%
Income $75,000 to $99,999	8.4%	9.3%	9.4%	9.5%	9.7%	9.8%	9.9%	11.0%	12.7%	14.9%	20.1%
Income $100,000 or More	7.5%	8.4%	8.5%	8.6%	8.7%	8.9%	9.0%	10.0%	11.6%	13.5%	18.4%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 8 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., 2010.

Table 4-44

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)	865.12	896.10	911.70	927.40	943.19	959.08	975.02	1,055.59	1,137.26	1,219.22	1,383.66
Age Under 19 Years	26.1%	25.0%	24.8%	24.7%	24.6%	24.5%	24.5%	24.9%	24.7%	24.2%	23.1%
Age 20 to 34	20.5%	21.5%	21.7%	21.8%	21.9%	21.9%	21.5%	19.9%	18.5%	18.2%	18.9%
Age 35 to 49	22.0%	19.5%	19.0%	18.5%	18.1%	17.7%	17.7%	18.2%	19.5%	19.7%	17.0%
Age 50 to 64	17.9%	19.4%	19.6%	19.7%	19.7%	19.8%	19.8%	18.8%	16.9%	15.5%	17.2%
Age 65 and over	13.4%	14.6%	14.8%	15.3%	15.7%	16.1%	16.4%	18.2%	20.4%	22.4%	23.8%
Median Age of Population (in years)	39	39	40	40	40	40	40	40	41	42	43
White Population (in thousands)	79.2%	77.6%	77.4%	77.2%	77.1%	76.9%	76.7%	75.8%	74.9%	74.1%	72.6%
Black Population (in thousands)	13.8%	14.3%	14.3%	14.3%	14.4%	14.4%	14.4%	14.6%	14.7%	14.8%	14.9%
Native American Population (in thousands)	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%
Asian and Pacific Islander Population (in thousands)	2.4%	2.6%	2.6%	2.6%	2.7%	2.7%	2.7%	2.8%	2.8%	2.8%	2.6%
Hispanic or Latino Population (in thousands)	3.7%	4.6%	4.7%	4.8%	5.0%	5.1%	5.2%	5.9%	6.6%	7.4%	9.0%
Male Population (in thousands)	49.8%	50.0%	50.1%	50.1%	50.2%	50.2%	50.2%	50.4%	50.5%	50.7%	51.1%
Total Employment (in thousands of jobs)	487.45	489.82	504.24	512.13	520.13	528.26	536.52	579.78	626.48	676.88	789.79
Farm Employment	0.5%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Mining	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%
Construction	9.0%	5.6%	5.6%	5.7%	5.7%	5.7%	5.7%	5.7%	5.8%	5.8%	5.9%
Manufacturing	3.4%	3.0%	3.0%	3.0%	3.0%	3.0%	2.9%	2.8%	2.7%	2.6%	2.4%
Wholesale Trade	2.6%	2.1%	2.1%	2.1%	2.0%	2.0%	2.0%	1.9%	1.8%	1.8%	1.6%
Retail Trade	12.0%	11.8%	11.8%	11.7%	11.7%	11.7%	11.7%	11.5%	11.4%	11.3%	10.9%
Transportation and Warehousing	1.8%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%
Information Employment	1.9%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%	1.6%
Finance and Insurance	3.6%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	4.0%	4.1%	4.1%	4.2%
Real Estate / Rental and Lease	5.5%	5.6%	5.6%	5.6%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%
Professional and Technical Services	5.2%	5.7%	5.7%	5.8%	5.9%	5.9%	6.0%	6.4%	6.8%	7.1%	8.0%

Table 4-44. Demographic and Employment Baseline Projections for Economic Impact Area FL-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Management	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
Administrative and Waste Services	7.0%	6.4%	6.4%	6.5%	6.5%	6.6%	6.7%	6.9%	7.2%	7.4%	7.9%
Educational Services	1.0%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%	1.3%	1.4%
Health Care and Social Assistance	8.9%	10.8%	10.9%	11.0%	11.1%	11.2%	11.3%	11.8%	12.4%	12.9%	14.0%
Arts, Entertainment, and Recreation	1.7%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	2.0%	2.0%	2.0%
Accommodation and Food Services	8.8%	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%	9.1%	9.1%	9.1%	9.0%
Other Services, Except Public Administration	6.2%	6.3%	6.3%	6.3%	6.3%	6.3%	6.4%	6.5%	6.5%	6.6%	6.7%
Federal Civilian Government	3.5%	3.7%	3.7%	3.7%	3.6%	3.6%	3.5%	3.3%	3.1%	2.9%	2.5%
Federal Military	6.9%	7.3%	7.2%	7.1%	7.0%	6.9%	6.8%	6.2%	5.7%	5.2%	4.4%
State and Local Government	9.1%	9.7%	9.7%	9.6%	9.6%	9.6%	9.5%	9.3%	9.1%	8.9%	8.4%
Total Earnings (in millions of 2005 dollars)	19,144.97	18,366.21	19,090.88	19,571.64	20,064.69	20,570.39	21,089.01	23,888.71	27,067.17	30,676.87	39,438.19
Farm Employment	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Forestry, Fishing, Related Activities	0.2%	0.2%	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%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Construction	8.1%	4.4%	4.8%	4.8%	4.7%	4.7%	4.6%	4.4%	4.2%	4.0%	3.7%
Manufacturing	4.8%	4.7%	4.8%	4.8%	4.8%	4.8%	4.7%	4.6%	4.5%	4.4%	4.2%
Wholesale Trade	3.0%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.3%	2.2%	2.2%	2.0%
Retail Trade	7.9%	7.3%	7.3%	7.3%	7.2%	7.2%	7.2%	7.0%	6.9%	6.7%	6.4%
Transportation and Warehousing	1.8%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.1%	2.1%	2.1%
Information Employment	2.4%	2.0%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Finance and Insurance	3.9%	3.6%	3.6%	3.6%	3.7%	3.7%	3.8%	4.0%	4.2%	4.4%	4.9%
Real Estate / Rental and Lease	3.1%	2.0%	2.0%	2.1%	2.1%	2.1%	2.1%	2.2%	2.3%	2.4%	2.5%
Professional and Technical Services	6.6%	6.8%	6.8%	6.9%	7.0%	7.1%	7.2%	7.7%	8.2%	8.8%	9.9%
Management	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%
Administrative and Waste Services	4.5%	3.7%	3.8%	3.8%	3.9%	3.9%	3.9%	4.2%	4.4%	4.6%	5.1%
Educational Services	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.9%	0.9%
Health Care and Social Assistance	10.0%	12.0%	12.0%	12.2%	12.3%	12.5%	12.6%	13.3%	14.0%	14.7%	16.2%
Arts, Entertainment, and Recreation	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Accommodation and Food Services	4.6%	4.4%	4.4%	4.4%	4.4%	4.4%	4.3%	4.3%	4.3%	4.3%	4.2%
Other Services, Except Public Administration	4.4%	4.3%	4.2%	4.2%	4.3%	4.3%	4.3%	4.4%	4.4%	4.5%	4.6%
Federal Civilian Government	6.8%	7.8%	7.6%	7.6%	7.5%	7.5%	7.4%	7.1%	6.8%	6.6%	6.0%

Table 4-44. Demographic and Employment Baseline Projections for Economic Impact Area FL-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Federal Military	14.5%	18.2%	18.0%	17.8%	17.6%	17.4%	17.2%	16.3%	15.4%	14.5%	12.8%
State and Local Government	10.5%	11.2%	11.1%	11.1%	11.0%	11.0%	11.0%	11.0%	10.9%	10.7%	10.4%
Total Personal Income per Capita (in 2005 dollars)	30,955	31,238	31,611	31,972	32,345	32,728	33,123	35,252	37,665	40,392	46,766
Woods & Poole Economics Wealth Index (U.S. = 100)	86.0	86.1	85.9	86.0	86.0	86.1	86.2	86.6	87.2	87.8	89.2
Persons per Household (in number of people)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.4	2.5
Mean Household Total Personal Income (in 2005 dollars)	70,630	68,775	69,464	70,092	70,758	71,474	72,225	76,569	81,867	88,167	103,926
Total Number of Households (in thousands)	339.50	355.60	362.19	369.74	377.31	384.77	392.23	428.80	464.20	497.98	559.96
Income < $10,000 (thousands of households, 2000$)	8.7%	8.1%	7.9%	7.8%	7.7%	7.5%	7.4%	6.6%	5.7%	4.9%	3.5%
Income $10,000 to $19,999	12.4%	11.6%	11.3%	11.1%	11.0%	10.8%	10.6%	9.4%	8.1%	7.0%	5.1%
Income $20,000 to $29,999	13.8%	12.9%	12.6%	12.4%	12.2%	12.0%	11.8%	10.4%	9.1%	7.8%	5.7%
Income $30,000 to $44,999	19.7%	18.9%	18.6%	18.3%	18.1%	17.8%	17.5%	15.6%	13.6%	11.7%	8.5%
Income $45,000 to $59,999	16.5%	17.4%	17.8%	18.0%	18.2%	18.3%	18.5%	19.1%	18.7%	17.1%	12.7%
Income $60,000 to $74,999	11.2%	12.0%	12.3%	12.5%	12.7%	13.0%	13.2%	15.0%	17.3%	19.3%	20.1%
Income $75,000 to $99,999	9.2%	9.8%	10.1%	10.2%	10.4%	10.6%	10.8%	12.3%	14.2%	16.5%	22.7%
Income $100,000 or More	8.6%	9.2%	9.5%	9.6%	9.8%	10.0%	10.2%	11.6%	13.4%	15.7%	21.7%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 7 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., 2010.

Table 4-45

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)	613.83	657.40	666.76	676.21	685.71	695.29	704.90	753.56	802.95	852.48	951.77
Age Under 19 Years	25.8%	24.6%	24.3%	24.2%	24.0%	23.9%	24.0%	24.2%	24.0%	23.7%	22.9%
Age 20 to 34	24.5%	25.3%	25.6%	25.8%	25.9%	25.9%	25.5%	22.8%	20.4%	19.9%	20.2%
Age 35 to 49	20.7%	18.9%	18.5%	18.1%	17.8%	17.5%	17.4%	18.7%	20.7%	21.4%	17.3%
Age 50 to 64	17.1%	18.2%	18.4%	18.3%	18.3%	18.3%	18.3%	17.6%	16.4%	15.2%	18.4%
Age 65 and over	11.9%	12.9%	13.2%	13.6%	14.0%	14.4%	14.8%	16.7%	18.5%	19.8%	21.2%
Median Age of Population (in years)	37	38	38	38	39	39	39	40	41	42	43
White Population (in thousands)	66.6%	65.2%	65.0%	64.8%	64.6%	64.4%	64.2%	63.2%	62.2%	61.2%	59.5%
Black Population (in thousands)	27.1%	27.5%	27.6%	27.6%	27.7%	27.7%	27.8%	28.2%	28.5%	28.9%	29.5%
Native American Population (in thousands)	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Asian and Pacific Islander Population (in thousands)	1.3%	1.5%	1.5%	1.5%	1.6%	1.6%	1.6%	1.7%	1.9%	2.0%	2.2%
Hispanic or Latino Population (in thousands)	4.5%	5.3%	5.4%	5.5%	5.6%	5.8%	5.9%	6.4%	6.9%	7.5%	8.4%
Male Population (in thousands)	50.3%	50.8%	50.8%	50.9%	50.9%	51.0%	51.0%	51.2%	51.3%	51.4%	51.6%
Total Employment (in thousands of jobs)	322.62	330.09	338.56	342.74	346.98	351.28	355.62	378.16	402.13	427.62	483.55
Farm Employment	2.6%	3.0%	3.0%	3.0%	2.9%	2.9%	2.9%	2.7%	2.5%	2.4%	2.1%
Forestry, Fishing, Related Activities	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%	1.3%
Mining	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Construction	6.5%	4.7%	4.7%	4.8%	4.8%	4.8%	4.8%	4.9%	5.0%	5.0%	5.1%
Manufacturing	4.6%	3.6%	3.6%	3.6%	3.5%	3.5%	3.5%	3.3%	3.2%	3.1%	2.8%
Wholesale Trade	2.1%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.7%	1.7%	1.6%	1.4%
Retail Trade	11.0%	10.3%	10.2%	10.2%	10.2%	10.2%	10.2%	10.0%	9.9%	9.8%	9.5%
Transportation and Warehousing	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%
Information Employment	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.5%	1.5%	1.3%
Finance and Insurance	3.2%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.6%
Real Estate / Rental and Lease	3.1%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.3%	3.3%	3.4%	3.4%
Professional and Technical Services	5.8%	6.2%	6.3%	6.4%	6.5%	6.6%	6.7%	7.1%	7.6%	8.1%	9.1%
Management	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%

Table 4-45. Demographic and Employment Baseline Projections for Economic Impact Area FL-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Administrative and Waste Services	4.8%	4.8%	4.8%	4.9%	4.9%	4.9%	5.0%	5.1%	5.3%	5.4%	5.7%
Educational Services	1.1%	1.6%	1.6%	1.6%	1.7%	1.7%	1.7%	1.9%	2.0%	2.2%	2.6%
Health Care and Social Assistance	8.6%	10.3%	10.4%	10.5%	10.7%	10.8%	10.9%	11.4%	12.0%	12.5%	13.6%
Arts, Entertainment, and Recreation	1.2%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.6%	1.6%	1.7%	1.7%
Accommodation and Food Services	6.7%	6.8%	6.8%	6.9%	6.9%	6.9%	6.9%	7.0%	7.2%	7.3%	7.5%
Other Services, Except Public Administration	6.2%	6.1%	6.1%	6.1%	6.2%	6.2%	6.2%	6.3%	6.3%	6.4%	6.5%
Federal Civilian Government	1.2%	1.3%	1.3%	1.3%	1.2%	1.2%	1.2%	1.1%	1.1%	1.0%	0.8%
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	25.3%	25.0%	24.8%	24.6%	24.4%	24.2%	24.0%	23.0%	22.0%	21.0%	19.2%
Total Earnings (in millions of 2005 dollars)	11,927.62	11,506.58	11,863.49	12,113.72	12,369.19	12,629.96	12,896.15	14,312.49	15,882.28	17,622.00	21,685.31
Farm Employment	1.3%	1.2%	1.3%	1.2%	1.2%	1.2%	1.2%	1.1%	1.0%	0.9%	0.7%
Forestry, Fishing, Related Activities	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%	1.1%	1.0%
Mining	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Utilities	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	0.9%	1.0%
Construction	6.4%	4.2%	4.5%	4.4%	4.4%	4.4%	4.4%	4.2%	4.1%	3.9%	3.6%
Manufacturing	5.9%	5.3%	5.5%	5.4%	5.4%	5.4%	5.4%	5.2%	5.1%	4.9%	4.6%
Wholesale Trade	2.7%	2.3%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%	2.2%	2.1%	1.9%
Retail Trade	7.2%	7.0%	7.0%	7.0%	6.9%	6.9%	6.9%	6.7%	6.6%	6.4%	6.1%
Transportation and Warehousing	1.5%	1.6%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.5%	1.5%
Information Employment	2.4%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.1%	2.0%	1.9%
Finance and Insurance	4.2%	4.5%	4.6%	4.6%	4.7%	4.7%	4.8%	5.0%	5.2%	5.4%	5.9%
Real Estate / Rental and Lease	1.1%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%
Professional and Technical Services	7.9%	8.1%	8.1%	8.2%	8.3%	8.4%	8.6%	9.2%	9.8%	10.4%	11.7%
Management	0.4%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%
Administrative and Waste Services	2.7%	2.7%	2.7%	2.7%	2.8%	2.8%	2.8%	2.9%	3.0%	3.1%	3.4%
Educational Services	0.5%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	1.0%	1.1%	1.4%
Health Care and Social Assistance	9.6%	11.6%	11.7%	11.8%	12.0%	12.1%	12.2%	12.9%	13.5%	14.1%	15.4%
Arts, Entertainment, and Recreation	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Accommodation and Food Services	2.7%	2.8%	2.7%	2.7%	2.7%	2.8%	2.8%	2.8%	2.8%	2.8%	2.9%
Other Services, Except Public Administration	5.2%	5.4%	5.3%	5.3%	5.3%	5.3%	5.4%	5.4%	5.5%	5.5%	5.6%
Federal Civilian Government	2.7%	3.2%	3.2%	3.2%	3.1%	3.1%	3.1%	3.0%	2.9%	2.8%	2.6%
Federal Military	0.5%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
State and Local Government	32.3%	32.2%	31.6%	31.4%	31.2%	31.0%	30.8%	29.9%	28.9%	27.9%	26.0%
Total Personal Income per Capita (in 2005 dollars)	27,200	26,656	26,811	27,063	27,321	27,585	27,856	29,328	31,005	32,905	37,298
Woods & Poole Economics Wealth Index (U.S. = 100)	67.0	66.8	66.7	66.6	66.5	66.4	66.3	65.9	65.6	65.4	64.9

Table 4-45. Demographic and Employment Baseline Projections for Economic Impact Area FL-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Persons per Household (in number of people)	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5
Mean Household Total Personal Income (in 2005 dollars)	57,688	56,795	57,352	57,724	58,116	58,529	58,970	61,586	64,884	68,883	78,850
Total Number of Households (in thousands)	236.50	255.39	259.32	263.92	268.49	273.05	277.56	299.51	320.40	339.91	374.75
Income < $10,000 (thousands of households, 2000$)	13.6%	12.8%	12.6%	12.4%	12.2%	12.1%	11.9%	11.0%	10.1%	8.9%	6.6%
Income $10,000 to $19,999	14.3%	13.6%	13.4%	13.2%	13.0%	12.8%	12.6%	11.7%	10.7%	9.4%	7.0%
Income $20,000 to $29,999	14.0%	13.3%	13.1%	12.9%	12.7%	12.5%	12.4%	11.5%	10.5%	9.3%	6.9%
Income $30,000 to $44,999	18.7%	18.8%	18.8%	18.8%	18.7%	18.6%	18.5%	17.9%	16.8%	14.9%	11.1%
Income $45,000 to $59,999	14.2%	14.9%	15.2%	15.4%	15.6%	15.8%	16.1%	17.2%	18.3%	19.3%	17.8%
Income $60,000 to $74,999	9.4%	9.9%	10.0%	10.2%	10.3%	10.5%	10.6%	11.5%	12.5%	14.3%	18.6%
Income $75,000 to $99,999	8.2%	8.6%	8.7%	8.8%	8.9%	9.1%	9.2%	9.9%	10.8%	12.4%	16.6%
Income $100,000 or More	7.8%	8.1%	8.3%	8.4%	8.5%	8.6%	8.7%	9.4%	10.2%	11.6%	15.4%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 15 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., 2010.

Table 4-46

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)	3,416.04	3,624.88	3,675.05	3,725.64	3,776.58	3,827.91	3,879.47	4,140.64	4,405.96	4,672.19	5,206.25
Age Under 19 Years	24.0%	23.4%	23.3%	23.2%	23.2%	23.1%	23.1%	23.1%	23.2%	23.1%	23.0%
Age 20 to 34	18.9%	19.4%	19.7%	19.8%	19.9%	19.9%	19.8%	19.2%	18.6%	18.3%	18.6%
Age 35 to 49	21.2%	19.6%	19.2%	18.8%	18.5%	18.2%	18.1%	17.9%	18.4%	18.8%	17.8%
Age 50 to 64	18.1%	19.5%	19.8%	19.8%	19.8%	19.9%	19.9%	19.1%	17.5%	16.2%	16.5%
Age 65 and over	17.8%	18.0%	18.1%	18.4%	18.6%	18.9%	19.1%	20.6%	22.3%	23.7%	24.1%
Median Age of Population (in years)	41	41	42	42	42	42	42	43	43	44	44
White Population (in thousands)	74.5%	71.2%	70.7%	70.1%	69.6%	69.1%	68.5%	65.9%	63.3%	60.7%	55.4%
Black Population (in thousands)	11.3%	11.8%	11.9%	12.0%	12.0%	12.1%	12.1%	12.3%	12.5%	12.6%	12.7%
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)	2.5%	2.9%	3.0%	3.0%	3.1%	3.2%	3.3%	3.6%	4.0%	4.4%	5.3%
Hispanic or Latino Population (in thousands)	11.4%	13.7%	14.1%	14.5%	14.9%	15.3%	15.8%	17.8%	19.9%	22.0%	26.4%
Male Population (in thousands)	48.7%	48.9%	49.0%	49.0%	49.1%	49.2%	49.2%	49.4%	49.5%	49.6%	49.7%
Total Employment (in thousands of jobs)	1,944.16	1,868.77	1,922.79	1,951.29	1,980.12	2,009.31	2,038.85	2,192.00	2,354.46	2,526.62	2,901.49
Farm Employment	1.0%	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
Forestry, Fishing, Related Activities	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%
Mining	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%
Construction	7.3%	4.8%	4.8%	4.9%	4.9%	4.9%	4.9%	5.0%	5.0%	5.1%	5.2%
Manufacturing	5.0%	4.4%	4.3%	4.3%	4.2%	4.1%	4.0%	3.7%	3.4%	3.1%	2.6%
Wholesale Trade	3.4%	3.4%	3.3%	3.3%	3.3%	3.3%	3.3%	3.2%	3.1%	3.1%	2.9%
Retail Trade	11.4%	11.1%	11.1%	11.0%	11.0%	11.0%	11.0%	10.8%	10.6%	10.4%	10.0%
Transportation and Warehousing	2.3%	2.5%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%
Information Employment	2.2%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.8%	1.7%
Finance and Insurance	5.8%	5.9%	5.9%	5.9%	5.9%	5.8%	5.8%	5.7%	5.7%	5.6%	5.4%

Table 4-46. Demographic and Employment Baseline Projections for Economic Impact Area FL-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Real Estate / Rental and Lease	4.5%	4.4%	4.5%	4.5%	4.5%	4.5%	4.5%	4.6%	4.6%	4.7%	4.8%
Professional and Technical Services	6.4%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.4%	7.4%	7.3%
Management	0.8%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%	1.3%	1.4%	1.4%	1.6%
Administrative and Waste Services	10.8%	7.8%	7.9%	8.0%	8.1%	8.2%	8.2%	8.7%	9.2%	9.6%	10.6%
Educational Services	1.3%	1.7%	1.7%	1.8%	1.8%	1.8%	1.8%	2.0%	2.1%	2.2%	2.5%
Health Care and Social Assistance	10.3%	13.0%	13.1%	13.2%	13.4%	13.5%	13.6%	14.2%	14.8%	15.4%	16.7%
Arts, Entertainment, and Recreation	2.0%	2.4%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%	2.3%	2.3%	2.2%
Accommodation and Food Services	6.8%	7.0%	7.0%	7.0%	6.9%	6.9%	6.8%	6.6%	6.4%	6.2%	5.8%
Other Services, Except Public Administration	5.9%	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%	6.1%	6.1%	6.0%	5.9%
Federal Civilian Government	1.3%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.3%
Federal Military	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.5%	0.5%
State and Local Government	9.9%	10.3%	10.3%	10.2%	10.2%	10.1%	10.1%	9.9%	9.6%	9.4%	8.9%
Total Earnings (in millions of 2005 dollars)	79,115.35	72,699.32	75,523.98	77,335.32	79,187.57	81,081.56	83,018.17	93,371.74	104,929.66	117,819.11	148,161.00
Farm Employment	0.5%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.2%
Forestry, Fishing, Related Activities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Mining	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%
Utilities	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%
Construction	7.5%	4.4%	4.8%	4.8%	4.7%	4.7%	4.7%	4.5%	4.3%	4.1%	3.8%
Manufacturing	6.8%	6.0%	6.1%	6.0%	5.9%	5.8%	5.8%	5.3%	4.9%	4.5%	3.8%
Wholesale Trade	4.9%	4.8%	4.9%	4.8%	4.8%	4.8%	4.8%	4.7%	4.6%	4.6%	4.4%
Retail Trade	8.3%	7.7%	7.7%	7.6%	7.6%	7.5%	7.5%	7.3%	7.0%	6.8%	6.3%
Transportation and Warehousing	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.2%	2.1%	2.1%
Information Employment	3.3%	3.1%	3.0%	3.0%	3.0%	3.0%	3.0%	2.9%	2.9%	2.8%	2.7%
Finance and Insurance	8.0%	7.2%	7.2%	7.2%	7.3%	7.3%	7.3%	7.4%	7.5%	7.6%	7.7%
Real Estate / Rental and Lease	2.3%	1.5%	1.5%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.8%	1.9%
Professional and Technical Services	8.1%	9.2%	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%	9.0%
Management	1.6%	2.4%	2.4%	2.5%	2.5%	2.6%	2.6%	2.8%	3.0%	3.3%	3.7%
Administrative and Waste Services	7.1%	4.8%	4.9%	4.9%	5.0%	5.1%	5.1%	5.4%	5.8%	6.1%	6.9%
Educational Services	0.8%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%	1.4%	1.5%	1.7%
Health Care and Social Assistance	12.1%	15.5%	15.4%	15.6%	15.7%	15.9%	16.0%	16.7%	17.4%	18.1%	19.5%
Arts, Entertainment, and Recreation	1.5%	2.0%	2.0%	2.0%	1.9%	1.9%	1.9%	1.9%	1.8%	1.7%	1.6%

Table 4-46. Demographic and Employment Baseline Projections for Economic Impact Area FL-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Accommodation and Food Services	3.9%	4.2%	4.1%	4.1%	4.0%	4.0%	4.0%	3.8%	3.6%	3.5%	3.2%
Other Services, Except Public Administration	4.0%	4.2%	4.1%	4.1%	4.1%	4.1%	4.1%	4.0%	4.0%	3.9%	3.8%
Federal Civilian Government	2.7%	3.5%	3.4%	3.4%	3.4%	3.4%	3.4%	3.5%	3.5%	3.5%	3.5%
Federal Military	1.2%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.3%	1.2%
State and Local Government	11.8%	12.8%	12.6%	12.6%	12.5%	12.5%	12.5%	12.3%	12.2%	12.0%	11.6%
Total Personal Income per Capita (in 2005 dollars)	33,224	31,323	31,639	32,001	32,373	32,754	33,144	35,240	37,593	40,226	46,260
Woods & Poole Economics Wealth Index (U.S. = 100)	79.5	77.2	77.2	77.2	77.1	77.1	77.1	77.0	77.0	77.0	77.0
Persons per Household (in number of people)	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Mean Household Total Personal Income (in 2005 dollars)	64,512	62,252	63,029	63,502	63,992	64,509	65,058	68,279	72,269	77,062	88,938
Total Number of Households (in thousands)	1,449.40	1,546.55	1,568.95	1,595.36	1,621.62	1,647.70	1,673.53	1,798.54	1,917.25	2,027.90	2,223.65
Income < $10,000 (thousands of households, 2000$)	9.1%	8.7%	8.6%	8.4%	8.3%	8.1%	8.0%	7.2%	6.3%	5.5%	4.1%
Income $10,000 to $19,999	13.8%	13.4%	13.1%	12.9%	12.6%	12.4%	12.1%	11.0%	9.7%	8.4%	6.2%
Income $20,000 to $29,999	14.7%	14.2%	13.9%	13.7%	13.5%	13.2%	12.9%	11.7%	10.3%	8.9%	6.6%
Income $30,000 to $44,999	19.6%	19.5%	19.3%	19.2%	19.0%	18.7%	18.5%	17.1%	15.3%	13.3%	9.9%
Income $45,000 to $59,999	15.1%	15.7%	16.0%	16.3%	16.6%	16.8%	17.1%	18.0%	18.6%	18.4%	15.2%
Income $60,000 to $74,999	9.7%	10.1%	10.3%	10.5%	10.7%	10.9%	11.1%	12.4%	14.2%	16.1%	18.7%
Income $75,000 to $99,999	8.4%	8.7%	8.9%	9.0%	9.2%	9.4%	9.6%	10.7%	12.2%	13.9%	18.7%
Income $100,000 or More	9.4%	9.7%	9.9%	10.1%	10.2%	10.4%	10.7%	11.9%	13.5%	15.4%	20.5%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 12 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., 2010.

Table 4-47

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)	5,960.39	6,210.44	6,294.73	6,379.76	6,465.42	6,551.79	6,638.56	7,078.51	7,525.98	7,975.38	8,877.71
Age Under 19 Years	24.7%	24.0%	23.9%	23.7%	23.6%	23.6%	23.5%	23.5%	23.2%	23.0%	22.8%
Age 20 to 34	18.5%	18.6%	18.6%	18.7%	18.7%	18.8%	18.8%	18.2%	17.8%	17.5%	17.4%
Age 35 to 49	22.1%	20.8%	20.4%	20.1%	19.7%	19.3%	19.0%	18.3%	18.2%	18.3%	17.2%
Age 50 to 64	17.5%	18.9%	19.1%	19.3%	19.4%	19.6%	19.7%	19.3%	18.3%	16.7%	16.1%
Age 65 and over	17.2%	17.8%	18.0%	18.2%	18.5%	18.8%	19.1%	20.7%	22.5%	24.4%	26.5%
Median Age of Population (in years)	44	45	45	45	45	45	45	46	46	46	46
White Population (in thousands)	46.6%	43.3%	42.7%	42.1%	41.5%	40.9%	40.4%	37.7%	35.3%	32.9%	28.5%
Black Population (in thousands)	16.5%	16.5%	16.6%	16.6%	16.6%	16.7%	16.7%	16.8%	16.9%	17.0%	16.9%
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)	1.9%	2.1%	2.1%	2.2%	2.2%	2.2%	2.3%	2.5%	2.6%	2.8%	3.2%
Hispanic or Latino Population (in thousands)	34.8%	37.9%	38.5%	39.0%	39.5%	40.0%	40.5%	42.8%	45.0%	47.2%	51.2%
Male Population (in thousands)	48.8%	49.0%	49.1%	49.1%	49.1%	49.1%	49.1%	49.2%	49.2%	49.2%	49.0%
Total Employment (in thousands of jobs)	3,395.35	3,329.05	3,426.96	3,479.99	3,533.68	3,588.03	3,643.04	3,928.30	4,230.99	4,551.70	5,249.44
Farm Employment	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.4%
Forestry, Fishing, Related Activities	0.4%	0.5%	0.5%	0.5%	0.5%	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%	0.1%	0.1%	0.1%	0.1%
Utilities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Construction	8.0%	5.0%	5.0%	5.0%	5.0%	5.1%	5.1%	5.3%	5.4%	5.6%	5.9%
Manufacturing	3.6%	2.9%	2.9%	2.9%	2.8%	2.8%	2.7%	2.5%	2.4%	2.2%	1.9%
Wholesale Trade	4.5%	4.3%	4.3%	4.2%	4.2%	4.2%	4.1%	3.9%	3.8%	3.6%	3.3%
Retail Trade	11.2%	11.1%	11.1%	11.0%	11.0%	10.9%	10.9%	10.7%	10.5%	10.3%	9.8%
Transportation and Warehousing	3.8%	3.9%	3.9%	3.9%	3.9%	3.8%	3.8%	3.7%	3.7%	3.6%	3.4%
Information Employment	2.0%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.4%

Table 4-47. Demographic and Employment Baseline Projections for Economic Impact Area FL-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Finance and Insurance	5.0%	4.9%	4.9%	4.8%	4.8%	4.8%	4.8%	4.7%	4.5%	4.4%	4.1%
Real Estate / Rental and Lease	6.0%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.0%	6.0%	5.9%
Professional and Technical Services	6.5%	6.8%	6.8%	6.8%	6.8%	6.9%	6.9%	7.0%	7.1%	7.1%	7.3%
Management	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	1.0%
Administrative and Waste Services	9.0%	7.9%	8.0%	8.0%	8.1%	8.2%	8.2%	8.6%	9.0%	9.3%	10.1%
Educational Services	1.8%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.6%	2.7%	2.8%	2.9%
Health Care and Social Assistance	9.1%	11.4%	11.5%	11.6%	11.7%	11.8%	11.8%	12.3%	12.8%	13.2%	14.2%
Arts, Entertainment, and Recreation	2.2%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.4%	2.4%
Accommodation and Food Services	7.2%	7.4%	7.3%	7.3%	7.3%	7.3%	7.2%	7.1%	7.0%	6.8%	6.5%
Other Services, Except Public Administration	7.7%	8.4%	8.4%	8.4%	8.4%	8.4%	8.5%	8.6%	8.7%	8.7%	8.9%
Federal Civilian Government	1.0%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.8%
Federal Military	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
State and Local Government	9.0%	9.6%	9.6%	9.5%	9.5%	9.5%	9.4%	9.3%	9.1%	9.0%	8.6%
Total Earnings (in millions of 2005 dollars)	146,349.28	133,109.32	138,104.63	141,438.36	144,845.84	148,328.48	151,887.81	170,888.07	192,042.06	215,564.73	270,666.64
Farm Employment	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	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%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Utilities	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Construction	9.4%	5.2%	5.6%	5.6%	5.6%	5.5%	5.5%	5.4%	5.3%	5.2%	4.9%
Manufacturing	4.4%	3.6%	3.7%	3.7%	3.6%	3.6%	3.5%	3.3%	3.1%	2.9%	2.5%
Wholesale Trade	6.8%	6.7%	6.9%	6.8%	6.8%	6.7%	6.7%	6.4%	6.2%	5.9%	5.4%
Retail Trade	8.5%	8.4%	8.4%	8.3%	8.3%	8.2%	8.2%	7.9%	7.7%	7.4%	6.9%
Transportation and Warehousing	4.0%	4.0%	3.9%	3.9%	3.9%	3.9%	3.8%	3.7%	3.6%	3.5%	3.2%
Information Employment	3.6%	3.4%	3.4%	3.4%	3.4%	3.3%	3.3%	3.3%	3.2%	3.1%	3.0%
Finance and Insurance	6.9%	6.2%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.0%
Real Estate / Rental and Lease	3.7%	2.4%	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%	2.6%	2.7%
Professional and Technical Services	8.3%	9.2%	9.1%	9.1%	9.1%	9.2%	9.2%	9.4%	9.5%	9.6%	9.9%
Management	1.3%	1.9%	1.9%	2.0%	2.0%	2.1%	2.1%	2.3%	2.5%	2.7%	3.2%
Administrative and Waste Services	6.2%	4.9%	4.9%	5.0%	5.0%	5.1%	5.1%	5.4%	5.6%	5.9%	6.5%
Educational Services	1.5%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.3%	2.4%	2.5%	2.7%

Table 4-47. Demographic and Employment Baseline Projections for Economic Impact Area FL-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	9.5%	12.2%	12.1%	12.2%	12.3%	12.4%	12.5%	13.0%	13.5%	14.1%	15.1%
Arts, Entertainment, and Recreation	1.6%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.8%	1.7%
Accommodation and Food Services	4.3%	4.6%	4.5%	4.5%	4.5%	4.5%	4.4%	4.3%	4.2%	4.1%	3.9%
Other Services, Except Public Administration	4.2%	4.6%	4.5%	4.5%	4.6%	4.6%	4.6%	4.6%	4.7%	4.7%	4.7%
Federal Civilian Government	2.2%	2.7%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%
Federal Military	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%
State and Local Government	11.8%	14.0%	13.8%	13.8%	13.8%	13.8%	13.8%	13.8%	13.7%	13.6%	13.5%
Total Personal Income per Capita (in 2005 dollars)	37,332	35,529	35,954	36,438	36,933	37,438	37,957	40,740	43,871	47,389	55,589
Woods & Poole Economics Wealth Index (U.S. = 100)	119.1	113.4	113.6	113.8	114.0	114.2	114.5	115.7	117.1	118.5	121.7
Persons per Household (in number of people)	2.5	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Mean Household Total Personal Income (in 2005 dollars)	92,182	86,404	87,645	88,598	89,600	90,651	91,754	98,070	105,688	114,735	137,497
Total Number of Households (in thousands)	2,337.90	2,434.13	2,469.25	2,510.68	2,551.90	2,592.85	2,633.43	2,830.25	3,017.88	3,193.31	3,504.05
Income < $10,000 (thousands of households, 2000$)	9.2%	8.8%	8.7%	8.5%	8.4%	8.2%	8.1%	7.2%	6.4%	5.6%	4.4%
Income $10,000 to $19,999	12.1%	11.7%	11.5%	11.4%	11.2%	11.0%	10.7%	9.6%	8.5%	7.5%	5.8%
Income $20,000 to $29,999	12.6%	12.3%	12.1%	11.9%	11.7%	11.5%	11.2%	10.0%	8.9%	7.9%	6.1%
Income $30,000 to $44,999	17.3%	17.0%	16.8%	16.5%	16.3%	16.0%	15.7%	14.0%	12.4%	11.0%	8.6%
Income $45,000 to $59,999	14.9%	15.3%	15.5%	15.6%	15.8%	15.9%	16.0%	16.2%	15.5%	14.1%	11.0%
Income $60,000 to $74,999	10.6%	11.0%	11.2%	11.4%	11.6%	11.8%	12.0%	13.5%	15.1%	16.3%	15.8%
Income $75,000 to $99,999	10.0%	10.3%	10.5%	10.7%	10.9%	11.1%	11.3%	12.8%	14.4%	16.4%	20.7%
Income $100,000 or More	13.1%	13.5%	13.8%	14.0%	14.3%	14.5%	14.8%	16.7%	18.8%	21.4%	27.6%

Note: Median age, wealth index, and mean household income is the average of the original Woods & Poole values for the 9 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., 2010.

Table 4-48

Baseline Population Projections (in thousands) by Economic Impact Area, 2010-2051

Model Year	Calendar Year	AL-1	MS-1	LA-1	LA-2	LA-3	LA-4	TX-1	TX-2	TX-3	FL-1	FL-2	FL-3	FL-4
	2010	725.48	470.61	334.72	587.88	1,126.87	1,267.52	1,771.25	626.33	6,192.43	896.10	657.40	3,624.88	6,210.44
	2011	731.11	474.64	336.53	593.59	1,140.44	1,278.34	1,807.15	634.39	6,299.99	911.70	666.76	3,675.05	6,294.73
1	2012	736.83	478.72	338.39	599.38	1,154.15	1,289.31	1,843.24	642.51	6,408.25	927.40	676.21	3,725.64	6,379.76
2	2013	742.62	482.85	340.27	605.23	1,167.97	1,300.40	1,879.50	650.70	6,517.13	943.19	685.71	3,776.58	6,465.42
3	2014	748.49	487.02	342.20	611.14	1,181.91	1,311.64	1,915.95	658.94	6,626.68	959.08	695.29	3,827.91	6,551.79
4	2015	754.41	491.23	344.15	617.10	1,195.92	1,322.96	1,952.51	667.23	6,736.63	975.02	704.90	3,879.47	6,638.56
5	2016	760.38	495.47	346.12	623.10	1,210.00	1,334.37	1,989.19	675.55	6,847.01	991.02	714.55	3,931.27	6,725.77
6	2017	766.41	499.75	348.12	629.15	1,224.17	1,345.89	2,026.02	683.92	6,957.91	1,007.10	724.26	3,983.37	6,813.50
7	2018	772.47	504.05	350.13	635.22	1,238.39	1,357.45	2,062.92	692.31	7,069.08	1,023.22	734.00	4,035.62	6,901.51
8	2019	778.57	508.38	352.16	641.34	1,252.68	1,369.10	2,099.94	700.73	7,180.66	1,039.39	743.77	4,088.08	6,989.92
9	2020	784.68	512.71	354.20	647.47	1,266.99	1,380.77	2,137.01	709.17	7,292.42	1,055.59	753.56	4,140.64	7,078.51
10	2021	790.89	517.11	356.28	653.68	1,281.45	1,392.61	2,174.35	717.69	7,405.11	1,071.93	763.44	4,193.71	7,168.00
11	2022	797.15	521.54	358.38	659.95	1,296.07	1,404.55	2,212.34	726.31	7,519.54	1,088.51	773.44	4,247.45	7,258.63
12	2023	803.46	526.02	360.48	666.29	1,310.86	1,416.60	2,251.00	735.03	7,635.74	1,105.36	783.58	4,301.88	7,350.40
13	2024	809.82	530.53	362.60	672.68	1,325.83	1,428.75	2,290.33	743.85	7,753.73	1,122.46	793.85	4,357.01	7,443.33
14	2025	815.74	534.70	364.61	678.54	1,339.29	1,439.98	2,323.71	751.75	7,855.87	1,137.26	802.95	4,405.96	7,525.98
15	2026	821.98	539.11	366.70	684.79	1,353.80	1,451.87	2,361.17	760.29	7,968.97	1,153.65	812.85	4,459.20	7,615.86
16	2027	828.26	543.56	368.81	691.09	1,368.46	1,463.87	2,399.24	768.92	8,083.69	1,170.28	822.88	4,513.09	7,706.81
17	2028	834.60	548.05	370.92	697.46	1,383.29	1,475.96	2,437.91	777.65	8,200.07	1,187.15	833.03	4,567.63	7,798.85
18	2029	840.98	552.58	373.05	703.88	1,398.27	1,488.16	2,477.21	786.48	8,318.13	1,204.26	843.31	4,622.84	7,891.99
19	2030	846.94	556.77	375.07	709.79	1,411.83	1,499.47	2,511.01	794.43	8,421.37	1,219.22	852.48	4,672.19	7,975.38
20	2031	853.17	561.19	377.17	716.05	1,426.34	1,511.37	2,548.50	802.95	8,534.58	1,235.62	862.38	4,725.46	8,065.35
21	2032	859.46	565.63	379.27	722.36	1,440.99	1,523.36	2,586.55	811.57	8,649.31	1,252.25	872.41	4,779.34	8,156.35
22	2033	865.79	570.12	381.39	728.73	1,455.80	1,535.45	2,625.17	820.28	8,765.59	1,269.10	882.54	4,833.83	8,248.36
23	2034	872.17	574.64	383.51	735.16	1,470.76	1,547.64	2,664.37	829.09	8,883.43	1,286.17	892.80	4,888.94	8,341.42
24	2035	878.13	578.84	385.53	741.09	1,484.37	1,558.97	2,698.47	837.06	8,987.43	1,301.24	902.01	4,938.54	8,425.26
25	2036	884.41	583.28	387.64	747.40	1,498.95	1,570.96	2,736.13	845.63	9,101.21	1,317.72	911.96	4,992.08	8,515.75
26	2037	890.74	587.76	389.77	753.76	1,513.68	1,583.03	2,774.31	854.28	9,216.42	1,334.42	922.03	5,046.20	8,607.21

Table 4-48. Baseline Population Projections (in thousands) by Economic Impact Area, 2010-2051 (continued).

Model Year	Calendar Year	AL-1	MS-1	LA-1	LA-2	LA-3	LA-4	TX-1	TX-2	TX-3	FL-1	FL-2	FL-3	FL-4
27	2038	897.11	592.27	391.90	760.17	1,528.55	1,595.20	2,813.03	863.02	9,333.09	1,351.32	932.20	5,100.91	8,699.66
28	2039	903.53	596.82	394.04	766.64	1,543.57	1,607.46	2,852.29	871.85	9,451.24	1,368.44	942.49	5,156.22	8,793.09
29	2040	909.54	601.05	396.08	772.62	1,557.29	1,618.89	2,886.77	879.89	9,556.30	1,383.66	951.77	5,206.25	8,877.71
30	2041	916.04	605.67	398.25	779.20	1,572.59	1,631.33	2,927.06	888.89	9,677.28	1,401.19	962.28	5,262.70	8,973.06
31	2042	922.60	610.31	400.43	785.83	1,588.03	1,643.87	2,967.91	897.99	9,799.78	1,418.94	972.89	5,319.75	9,069.43
32	2043	929.20	615.00	402.62	792.52	1,603.64	1,656.50	3,009.33	907.18	9,923.84	1,436.92	983.63	5,377.43	9,166.84
33	2044	935.84	619.72	404.83	799.26	1,619.39	1,669.23	3,051.33	916.46	10,049.47	1,455.12	994.48	5,435.73	9,265.29
34	2045	942.54	624.47	407.04	806.06	1,635.30	1,682.06	3,093.91	925.84	10,176.68	1,473.56	1,005.45	5,494.66	9,364.80
35	2046	949.28	629.27	409.27	812.92	1,651.37	1,694.99	3,137.09	935.31	10,305.51	1,492.22	1,016.55	5,554.23	9,465.38
36	2047	956.07	634.09	411.51	819.84	1,667.59	1,708.02	3,180.87	944.88	10,435.97	1,511.13	1,027.76	5,614.45	9,567.04
37	2048	962.91	638.96	413.76	826.82	1,683.97	1,721.15	3,225.27	954.55	10,568.08	1,530.27	1,039.10	5,675.32	9,669.80
38	2049	969.80	643.86	416.03	833.86	1,700.52	1,734.37	3,270.28	964.32	10,701.87	1,549.66	1,050.57	5,736.85	9,773.65
39	2050	976.73	648.81	418.30	840.95	1,717.22	1,747.70	3,315.92	974.19	10,837.34	1,569.29	1,062.16	5,799.05	9,878.62
40	2051	983.72	653.78	420.59	848.11	1,734.09	1,761.14	3,362.20	984.16	10,974.54	1,589.17	1,073.88	5,861.92	9,984.72

Note: 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., 2010.

Table 4-49

Peak Population Projected from a WPA Proposed Action as a Percent of Total Population

Economic Impact Area	WPA Low				WPA High			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	855	2027	2,399,240	0.0%	1,457	2027	2,399,240	0.1%
TX-2	501	2018	692,310	0.1%	810	2015	667,230	0.1%
TX-3	4,894	2015	6,736,630	0.1%	8,034	2017	6,957,910	0.1%
Louisiana (LA)								
LA-1	59	2015	344,150	0.0%	104	2015	344,150	0.0%
LA-2	474	2015	617,100	0.1%	778	2015	617,100	0.1%
LA-3	850	2015	1,195,920	0.1%	1,378	2015	1,195,920	0.1%
LA-4	273	2015	1,322,960	0.0%	458	2015	1,322,960	0.0%
Florida (FL)								
FL-1	65	2018	1,023,220	0.0%	119	2015	975,020	0.0%
FL-2	130	2018	734,000	0.0%	237	2015	704,900	0.0%
FL-3	141	2018	4,035,620	0.0%	260	2015	3,879,470	0.0%
FL-4	103	2015	6,638,560	0.0%	192	2015	6,638,560	0.0%
Alabama (AL)								
AL-1	174	2027	828,260	0.0%	307	2015	754,410	0.0%
Mississippi (MS)								
MS-1	152	2027	543,560	0.0%	252	2027	543,560	0.0%

Sources: Peak employment output from BOEMRE’s economic impact model (MAG-PLAN) (Kaplan et al., 2011).
Baseline population projections based on Woods & Poole Economics, Inc. (2010).

Table 4-50

Peak Employment Projected from Cumulative OCS Programs as a Percent of Total Employment

Economic Impact Area	Cumulative Low				Cumulative High			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	6,437	2030	1,151,170	0.6%	10,006	2031	1,168,650	0.9%
TX-2	2,445	2031	403,920	0.6%	4,024	2031	403,920	1.0%
TX-3	66,355	2030	4,951,730	1.3%	97,636	2031	5,028,340	1.9%
Louisiana (LA)								
LA-1	5,972	2031	222,480	2.7%	9,619	2031	222,480	4.3%
LA-2	13,542	2030	408,210	3.3%	21,238	2031	412,680	5.1%
LA-3	23,223	2030	859,360	2.7%	36,791	2031	870,010	4.2%
LA-4	12,334	2030	883,430	1.4%	19,610	2031	890,790	2.2%
Florida (FL)								
FL-1	1,022	2031	687,750	0.1%	1,728	2031	687,750	0.3%
FL-2	2,025	2031	433,040	0.5%	3,459	2031	433,040	0.8%
FL-3	2,247	2031	2,563,070	0.1%	3,808	2031	2,563,070	0.1%
FL-4	1,701	2031	4,619,550	0.0%	2,936	2031	4,619,550	0.1%
Alabama (AL)								
AL-1	2,624	2030	445,720	0.6%	4,463	2031	450,470	1.0%
Mississippi (MS)								
MS-1	1,833	2030	293,520	0.6%	3,086	2031	296,020	1.0%

Sources: Peak employment output from BOEMRE's economic impact model (MAG-PLAN) (Kaplan et al., 2011).
Baseline population projections based on Woods & Poole Economics, Inc. (2010).

Table 4-51

Baseline Employment Projections (in Thousands) by Economic Impact Area

Model Year	Calendar Year	AL1	MS1	LA1	LA2	LA3	LA4	TX1	TX2	TX3	FL1	FL2	FL3	FL4	Total
	2010	353.63	243.91	177.73	321.93	663.02	728.32	840.00	309.97	3,596.00	489.82	330.09	1,868.77	3,329.05	13,252.23
	2011	362.59	249.36	182.05	330.21	680.63	745.53	864.86	317.96	3,700.61	504.24	338.56	1,922.79	3,426.96	13,626.35
1	2012	366.69	251.56	183.91	334.03	689.17	752.64	878.23	321.85	3,758.99	512.13	342.74	1,951.29	3,479.99	13,823.22
2	2013	370.81	253.76	185.81	337.89	697.80	759.77	891.81	325.78	3,818.15	520.13	346.98	1,980.12	3,533.68	14,022.49
3	2014	374.97	255.98	187.70	341.78	706.51	766.93	905.55	329.76	3,878.09	528.26	351.28	2,009.31	3,588.03	14,224.14
4	2015	379.15	258.22	189.62	345.70	715.33	774.11	919.48	333.78	3,938.83	536.52	355.62	2,038.85	3,643.04	14,428.24
5	2016	383.37	260.47	191.54	349.65	724.23	781.30	933.58	337.82	4,000.39	544.90	360.02	2,068.76	3,698.74	14,634.78
6	2017	387.62	262.73	193.50	353.63	733.24	788.52	947.87	341.92	4,062.77	553.43	364.46	2,099.03	3,755.10	14,843.79
7	2018	391.90	265.01	195.46	357.65	742.34	795.74	962.34	346.07	4,125.95	562.07	368.98	2,129.66	3,812.15	15,055.30
8	2019	396.21	267.30	197.44	361.69	751.53	802.98	977.00	350.24	4,189.99	570.86	373.54	2,160.65	3,869.88	15,269.31
9	2020	400.55	269.62	199.43	365.76	760.83	810.24	991.85	354.48	4,254.86	579.78	378.16	2,192.00	3,928.30	15,485.86
10	2021	404.99	271.97	201.47	369.93	770.43	817.53	1,007.28	358.83	4,322.32	589.12	382.95	2,224.49	3,988.84	15,710.16
11	2022	409.48	274.34	203.54	374.15	780.14	824.89	1,022.95	363.24	4,390.84	598.61	387.81	2,257.47	4,050.31	15,937.78
12	2023	414.02	276.74	205.62	378.41	789.98	832.32	1,038.87	367.71	4,460.45	608.25	392.73	2,290.93	4,112.73	16,168.77
13	2024	418.61	279.15	207.73	382.73	799.95	839.81	1,055.03	372.22	4,531.17	618.06	397.71	2,324.89	4,176.11	16,403.17
14	2025	422.75	281.38	209.65	386.61	808.81	846.71	1,069.01	376.26	4,592.14	626.48	402.13	2,354.46	4,230.99	16,607.39
15	2026	427.35	283.81	211.77	390.93	818.92	854.06	1,085.44	380.83	4,664.06	636.56	407.23	2,388.90	4,295.13	16,844.98
16	2027	431.99	286.26	213.92	395.30	829.16	861.46	1,102.12	385.46	4,737.10	646.80	412.39	2,423.83	4,360.25	17,086.04
17	2028	436.69	288.73	216.09	399.71	839.52	868.93	1,119.07	390.14	4,811.29	657.21	417.62	2,459.28	4,426.35	17,330.62
18	2029	441.43	291.22	218.28	404.18	850.02	876.47	1,136.27	394.88	4,886.64	667.78	422.92	2,495.24	4,493.45	17,578.77
19	2030	445.72	293.52	220.27	408.21	859.36	883.43	1,151.17	399.12	4,951.73	676.88	427.62	2,526.62	4,551.70	17,795.35
20	2031	450.47	296.02	222.48	412.68	870.01	890.79	1,168.65	403.92	5,028.34	687.75	433.04	2,563.07	4,619.55	18,046.77
21	2032	455.27	298.55	224.71	417.21	880.78	898.22	1,186.39	408.78	5,106.13	698.79	438.53	2,600.03	4,688.42	18,301.82
22	2033	460.12	301.09	226.97	421.78	891.69	905.70	1,204.41	413.70	5,185.13	710.01	444.09	2,637.53	4,758.32	18,560.55
23	2034	465.02	303.66	229.25	426.41	902.73	913.25	1,222.69	418.67	5,265.35	721.41	449.72	2,675.58	4,829.26	18,823.00
24	2035	469.47	306.03	231.32	430.59	912.57	920.25	1,238.56	423.13	5,334.78	731.22	454.72	2,708.83	4,890.99	19,052.46
25	2036	474.37	308.61	233.62	435.21	923.76	927.61	1,257.14	428.15	5,416.31	742.93	460.49	2,747.36	4,962.68	19,318.25
26	2037	479.32	311.21	235.94	439.89	935.09	935.02	1,275.99	433.24	5,499.10	754.83	466.32	2,786.44	5,035.42	19,587.82
27	2038	484.33	313.83	238.28	444.61	946.56	942.50	1,295.13	438.38	5,583.14	766.92	472.24	2,826.08	5,109.23	19,861.23
28	2039	489.39	316.47	240.64	449.38	958.16	950.04	1,314.56	443.59	5,668.48	779.21	478.22	2,866.28	5,184.12	20,138.54
29	2040	493.98	318.92	242.80	453.71	968.53	957.04	1,331.45	448.26	5,742.46	789.79	483.55	2,901.49	5,249.44	20,381.40
30	2041	499.14	321.61	245.21	458.58	980.40	964.70	1,351.41	453.58	5,830.23	802.44	489.67	2,942.76	5,326.39	20,666.11
31	2042	504.35	324.31	247.64	463.51	992.42	972.41	1,371.68	458.97	5,919.33	815.29	495.88	2,984.61	5,404.46	20,954.88
32	2043	509.62	327.05	250.10	468.48	1,004.59	980.19	1,392.26	464.42	6,009.81	828.36	502.17	3,027.07	5,483.67	21,247.77
33	2044	514.94	329.80	252.58	473.52	1,016.91	988.02	1,413.14	469.94	6,101.66	841.63	508.53	3,070.12	5,564.05	21,544.84
34	2045	520.32	332.58	255.09	478.60	1,029.38	995.93	1,434.33	475.52	6,194.92	855.11	514.98	3,113.79	5,645.61	21,846.15
35	2046	525.76	335.38	257.62	483.74	1,042.00	1,003.89	1,455.85	481.17	6,289.60	868.81	521.51	3,158.08	5,728.36	22,151.75
36	2047	531.25	338.20	260.17	488.94	1,054.78	1,011.92	1,477.68	486.88	6,385.73	882.72	528.12	3,203.00	5,812.32	22,461.72
37	2048	536.80	341.05	262.75	494.19	1,067.71	1,020.01	1,499.84	492.66	6,483.33	896.87	534.81	3,248.56	5,897.52	22,776.11
38	2049	542.40	343.92	265.36	499.49	1,080.81	1,028.17	1,522.34	498.52	6,582.42	911.23	541.59	3,294.77	5,983.96	23,094.99
39	2050	548.07	346.82	267.99	504.86	1,094.06	1,036.39	1,545.17	504.44	6,683.02	925.83	548.46	3,341.64	6,071.67	23,418.42
40	2051	553.79	349.74	270.65	510.28	1,107.48	1,044.68	1,568.35	510.43	6,785.16	940.66	555.41	3,389.17	6,160.67	23,746.47

Source: Woods & Poole Economics, Inc. (2010). .

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.

Table 4-52

Gulf Coast Monthly Unemployment Rates during 2010

Labor Market Area	January	February	March	April	May	June	July	August	September	October	November	December
National Unemployment Rate	9.7	9.7	9.7	9.8	9.6	9.5	9.5	9.6	9.6	9.7	9.8	9.4
Texas	8.6	8.4	8.3	7.9	7.9	8.4	8.4	8.3	8.0	7.9	8.2	8.0
Beaumont-Port Arthur	10.8	10.6	10.8	10.3	10.4	10.9	10.8	10.7	10.5	10.3	10.9	10.9
Brownsville	11.2	11.2	10.9	10.5	10.5	11.4	11.3	11.4	11.1	11.0	11.7	11.7
Corpus Christi	8.2	8.0	7.8	7.6	7.7	8.4	8.3	8.1	8.0	7.9	8.3	8.2
Houston-Sugarland-Baytown	8.8	8.6	8.6	8.2	8.2	8.7	8.7	8.6	8.3	8.2	8.5	8.3
Victoria	8.1	8.2	7.9	7.4	7.3	7.7	7.8	7.6	7.3	7.3	7.4	7.1
Louisiana	7.9	6.9	6.8	6.6	7.2	8.3	8.0	8.2	7.7	7.5	7.3	7.2
Baton Rouge	7.6	6.6	6.6	6.4	7.3	8.5	8.1	8.3	7.8	7.6	7.4	7.2
Houma-Bayou Cane-Thibodaux	6.0	5.0	5.0	4.9	5.3	6.0	5.3	5.8	5.4	5.4	5.3	5.0
Lafayette	6.5	5.6	5.5	5.3	5.7	6.6	6.2	6.5	6.1	6.1	5.9	5.6
Lake Charles	7.4	6.3	6.3	6.2	6.7	7.8	7.4	7.7	7.3	7.0	6.9	6.7
New Orleans	8.1	8.2	7.9	7.4	7.3	7.7	7.8	7.6	7.3	7.3	7.4	7.1
Mississippi	12.0	11.3	10.8	9.9	10.4	10.7	11.1	9.7	9.9	9.8	9.8	9.8
Biloxi-Gulfport	10.2	9.6	9.2	8.6	9.0	9.0	9.2	8.0	8.6	8.9	8.7	8.6
Alabama	10.9	10.6	10.1	9.3	9.0	9.6	9.3	9.4	9.0	8.9	9.0	8.8
Mobile	11.7	11.2	10.8	10.2	9.9	10.0	9.8	10.1	9.7	9.6	9.9	9.7
Florida	11.5	11.4	11.3	10.9	10.9	11.4	11.9	12.1	11.8	11.6	12.1	11.7
Miami-Fort Lauderdale-Pompano Beach	10.8	10.8	11.0	10.8	11.0	11.5	11.9	12.2	11.7	11.8	11.9	11.8
Panama City	11.5	10.8	9.8	9.2	9.1	9.1	9.4	9.8	10.4	10.6	11.7	11.8
Pensacola	10.9	10.8	10.4	9.9	9.8	10.4	10.9	10.6	10.4	10.2	11.1	10.8
Tampa-St. Petersburg-Clearwater	12.4	12.1	11.9	11.6	11.5	11.9	12.3	12.4	12.2	12.0	12.6	12.2
Tallahassee	8.5	8.5	8.2	7.7	7.9	8.5	9.2	8.9	8.6	8.3	9.1	8.9

Note: Unemployment rates shown as percent.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2011b.

Table 4-53

Low-Case Employment Projections for a WPA Proposed Action by Economic Impact Area

Economic Impact Area	Jobs (full- and part-time) from Industry Expenditure Effects						
	Total (40-year sum)				Average Annual	Peak Annual	Peak Year
	Direct	Indirect	Induced	Total			
Texas (TX)							
TX-1	958	418	1,838	3,215	80	330	2027
TX-2	822	243	848	1,914	48	193	2018
TX-3	4,610	3,839	12,162	20,611	515	1,890	2015
All Texas EIA’s	6,390	4,500	14,849	25,739	643	2,337	2015
Rest of Texas	1,048	613	4,028	5,690	142	573	2018
Texas Total	7,438	5,113	18,877	31,429	786	2,889	2015
Louisiana (LA)							
LA-1	61	17	163	240	6	23	2015
LA-2	241	153	1,571	1,966	49	183	2015
LA-3	191	111	2,936	3,238	81	328	2015
LA-4	133	86	922	1,141	29	105	2015
All Louisiana EIA’s	627	367	5,591	6,585	165	639	2015
Rest of Louisiana	116	76	715	906	23	90	2015
Louisiana Total	742	443	6,306	7,491	187	729	2015
Florida (FL)							
FL-1	76	39	160	274	7	25	2018
FL-2	143	58	341	542	14	50	2018
FL-3	126	77	400	604	15	55	2018
FL-4	101	68	299	468	12	40	2015
All Florida EIA’s	446	242	1,201	1,888	47	170	2018
Rest of Florida	170	129	550	849	21	75	2018
Florida Total	616	371	1,750	2,737	68	245	2018
Alabama (AL)							
AL-1	129	69	504	703	18	67	2027
Rest of Alabama	381	221	969	1,572	39	148	2015
Alabama Total	511	290	1,474	2,275	57	211	2015
Mississippi (MS)							
MS-1	115	36	334	485	12	59	2027
Rest of Mississippi	333	125	753	1,212	30	116	2027
Mississippi Total	449	161	1,087	1,696	42	174	2027
Total All EIA’s*	7,707	5,214	22,479	35,400	885	3,271	
Total 5 Gulf Coast States*	9,756	6,377	29,494	45,628	1,141	4,248	
Rest of U.S.	1,521	1,919	12,122	15,563	389	1,485	2015
Total U.S.	11,278	8,297	41,616	61,191	1,530	5,707	2015

Note: Totals may not sum due to rounding.
* Adds peak from different years.

Source: Employment output from BOEMRE’s economic impact model (MAG-PLAN) (Kaplan et al., 2011).

Table 4-54

High-Case Employment Projections for a WPA Proposed Action by Economic Impact Area

Economic Impact Area	Jobs (full- and part-time) from Industry Expenditure Effects						
	Total (40-year sum)				Average Annual	Peak Annual	Peak Year
	Direct	Indirect	Induced	Total			
Texas (TX)							
TX-1	1,917	836	3,440	6,193	155	563	2027
TX-2	1,516	457	1,579	3,552	89	313	2015
TX-3	8,136	6,708	21,037	35,881	897	3,102	2017
All Texas EIA’s	11,570	8,001	26,056	45,627	1,141	3,842	2017
Rest of Texas	1,893	1,104	7,503	10,500	263	955	2015
Texas Total	13,463	9,105	33,559	56,127	1,403	4,785	2015
Louisiana (LA)							
LA-1	112	31	309	452	11	40	2015
LA-2	484	288	2,826	3,598	90	301	2015
LA-3	402	220	5,342	5,964	149	532	2015
LA-4	261	164	1,693	2,118	53	177	2015
All Louisiana EIA’s	1,259	703	10,170	12,132	303	1,049	2015
Rest of Louisiana	215	136	1,326	1,676	42	154	2015
Louisiana Total	1,474	839	11,496	13,809	345	1,203	2015
Florida (FL)							
FL-1	141	72	311	524	13	46	2015
FL-2	272	109	666	1,047	26	92	2015
FL-3	236	142	779	1,157	29	100	2015
FL-4	194	128	585	907	23	74	2015
All Florida EIA’s	843	451	2,341	3,635	91	312	2015
Rest of Florida	325	242	1,118	1,685	42	141	2015
Florida Total	1,168	693	3,459	5,321	133	453	2015
Alabama (AL)							
AL-1	244	127	996	1,367	34	118	2015
Rest of Alabama	704	397	1,851	2,952	74	265	2015
Alabama Total	948	524	2,847	4,319	108	384	2015
Mississippi (MS)							
MS-1	255	77	660	992	25	97	2027
Rest of Mississippi	635	233	1,443	2,311	58	198	2015
Mississippi Total	890	310	2,103	3,303	83	275	2015
Total All EIA’s*	14,171	9,359	40,223	63,753	1,594	5,419	
Total 5 Gulf Coast States*	17,943	11,472	53,464	82,878	2,072	7,100	
Rest of U.S.	2,731	3,390	21,569	27,689	692	2,489	2015
Total U.S.	20,674	14,861	75,032	110,568	2,764	9,589	2015

Note: Totals may not sum due to rounding.
* Adds peak from different years.

Source: Employment output from BOEMRE’s economic impact model (MAG-PLAN) (Kaplan et al., 2011).

Table 4-55

Peak Employment Projected from a WPA Proposed Action as a Percent of Total Employment

Economic Impact Area	WPA Low				WPA High			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	330	2027	1,102,120	0.0%	563	2027	1,102,120	0.1%
TX-2	193	2018	346,070	0.1%	313	2015	333,780	0.1%
TX-3	1,890	2015	3,938,830	0.0%	3,102	2017	4,062,770	0.1%
Louisiana (LA)								
LA-1	23	2015	189,620	0.0%	40	2015	189,620	0.0%
LA-2	183	2015	345,700	0.1%	301	2015	345,700	0.1%
LA-3	328	2015	715,330	0.0%	532	2015	715,330	0.1%
LA-4	105	2015	774,110	0.0%	177	2015	774,110	0.0%
Florida (FL)								
FL-1	25	2018	562,070	0.0%	46	2015	536,520	0.0%
FL-2	50	2018	368,980	0.0%	92	2015	355,620	0.0%
FL-3	55	2018	2,129,660	0.0%	100	2015	2,038,850	0.0%
FL-4	40	2015	3,643,040	0.0%	74	2015	3,643,040	0.0%
Alabama (AL)								
AL-1	67	2027	431,990	0.0%	118	2015	379,150	0.0%
Mississippi (MS)								
MS-1	59	2027	286,260	0.0%	97	2027	286,260	0.0%

Sources: Peak employment output from BOEMRE’s economic impact model (MAG-PLAN) (Kaplan et al., 2011). Baseline employment projections based on Woods & Poole Economics, Inc. (2010).

Table 4-56

Personnel, Vessels, Aircraft, and Containment Boom Deployed for *Deepwater Horizon* Spill Response Activity*

Date	Personnel	Vessels	Aircraft	Containment Boom Deployed (ft)
April 22, 2010	N/R	2	5	N/R
April 25, 2010	500	30	N/R	21,340
April 30, 2010	2000	75	N/R	217,000
May 5, 2010	7,900	200	N/R	564,991
May 10, 2010	10,000	290	N/R	1,000,000
May 15, 2010	17,500	600	N/R	1,250,000
May 20, 2010	24,000	1,000	N/R	1,990,000
May 25, 2010	22,000	1,200	N/R	1,800,000
May 30, 2010	20,000	1,400	N/R	1,900,000
June 5, 2010	20,000	2,600	N/R	2,100,000
June 10, 2010	24,000	4,400	64	2,200,000
June 15, 2010	29,000	5,000	93	2,370,000
June 20, 2010	33,000	6,100	107	2,470,000
June 25, 2010	37,000	6,510	96	2,600,000
June 30, 2010	42,000	6,850	122	2,760,000
July 5, 2010	45,000	7,040	113	2,950,000
July 10, 2010	46,500	6,840	120	3,060,000
July 15, 2010	44,000	6,870	119	3,270,000
July 20, 2010	42,000	5,300	120	3,460,000
July 25, 2010	30,000	3,600	108	3,410,000
July 30, 2010	32,600	4,400	97	3,400,000
August 5, 2010	31,800	4,800	90	3,000,000
August 10, 2010	31,100	4,900	75	2,400,000
August 15, 2010	28,200	4,300	75	2,200,000
August 20, 2010	30,200	4,300	72	2,300,000
August 25, 2010	30,294	4,375	72	2,300,000
August 28, 2010+	29,705	5,059	64	2,300,000
September 5, 2010	28,000	++4,000	N/R	1,570,000
September 10, 2010	27,000	3,600	N/R	999,000
September 15, 2010	25,900	4,700	N/R	714,000
September 17, 2010**	25,200	2,600	N/R	670,000
October 12, 2010	16,292	N/R	N/R	19,540
November 22, 2010	8,198	552	N/R	N/R
December 1, 2010	6,471	451	N/R	N/R
December 10, 2010	6,579	382	N/R	N/R
December 23, 2010	6,170	260	N/R	N/R
January 6, 2011	5,428	345	N/R	N/R
January 13, 2011	5,428	348	N/R	N/R

N/R = Not reported.

* Compiled from UIC Daily Operations Reports from the official *Deepwater Horizon* Spill Response website or from the RestoreTheGulf.gov website (RestoreTheGulf.gov, 2011).

** Last date of daily and itemized reporting.

\+ No reports for August 29 or September 1, 2010.

++ Aircraft included in vessel count from this point forward.

Table 4-57

Low Cumulative Case Employment Projections by Economic Impact Area

Economic Impact Area	Jobs (full- and part-time) from Industry Expenditure Effects						
	Total (40-year sum)				Average Annual	Peak Annual	Peak Year
	Direct	Indirect	Induced	Total			
Texas (TX)							
TX-1	50,776	22,882	125,526	199,183	4,980	6,437	2030
TX-2	29,341	9,178	47,301	85,820	2,146	2,445	2031
TX-3	521,405	417,718	1,486,324	2,425,448	60,636	66,355	2030
All Texas EIA's	601,522	449,778	1,659,151	2,710,451	67,761	74,924	2030
Rest of Texas	59,121	44,042	369,852	473,016	11,825	13,106	2031
Texas Total	660,643	493,820	2,029,003	3,183,466	79,587	88,030	2030
Louisiana (LA)							
LA-1	81,698	34,574	103,627	219,899	5,497	5,972	2031
LA-2	119,872	53,284	316,518	489,674	12,242	13,542	2030
LA-3	144,446	85,260	615,433	845,138	21,128	23,223	2030
LA-4	115,559	60,923	275,736	452,218	11,305	12,334	2030
All Louisiana EIA's	461,575	234,041	1,311,313	2,006,929	50,173	55,053	2030
Rest of Louisiana	82,784	30,899	172,061	285,745	7,144	7,731	2031
Louisiana Total	544,359	264,940	1,483,375	2,292,674	57,317	62,775	2030
Florida (FL)							
FL-1	10,093	5,182	21,672	36,947	924	1,022	2031
FL-2	19,334	7,835	46,157	73,325	1,833	2,025	2031
FL-3	16,871	10,311	53,990	81,173	2,029	2,247	2031
FL-4	13,492	9,056	38,613	61,161	1,529	1,701	2031
All Florida EIA's	59,789	32,385	160,433	252,607	6,315	6,995	2031
Rest of Florida	22,905	17,342	73,647	113,894	2,847	3,154	2030
Florida Total	82,694	49,726	234,080	366,501	9,163	10,148	2031
Alabama (AL)							
AL-1	16,957	9,113	68,186	94,256	2,356	2,624	2030
Rest of Alabama	51,407	29,281	131,136	211,824	5,296	5,854	2030
Alabama Total	68,363	38,394	199,322	306,079	7,652	8,478	2030
Mississippi (MS)							
MS-1	14,442	4,599	42,530	61,570	1,539	1,833	2030
Rest of Mississippi	44,114	16,475	99,424	160,013	4,000	4,480	2030
Mississippi Total	58,555	21,073	141,954	221,583	5,540	6,313	2030
Total All EIA's*	1,154,285	729,915	3,241,613	5,125,812	128,145	141,428	2030
Total 5 Gulf Coast States*	1,414,615	867,954	4,087,734	6,370,303	159,258	175,744	2030
Rest of U.S.	203,684	254,043	1,620,774	2,078,501	51,963	57,699	2030
Total U.S.	1,618,299	1,121,996	5,708,509	8,448,804	211,220	233,378	2030

Note: Totals may not sum due to rounding.
* Adds peak from different years.

Source: Employment output from BOEMRE's economic impact model (MAG-PLAN) (Kaplan et al., 2011).

Table 4-58

High Cumulative Case Employment Projections by Economic Impact Area

Economic Impact Area	Jobs (full- and part-time) from Industry Expenditure Effects						
	Total (40-year sum)				Average Annual	Peak Annual	Peak Year
	Direct	Indirect	Induced	Total			
Texas (TX)							
TX-1	83,786	37,713	191,331	312,830	7,821	10,006	2031
TX-2	48,043	15,136	76,889	140,068	3,502	4,024	2031
TX-3	774,073	614,308	2,192,724	3,581,105	89,528	97,636	2031
All Texas EIA's	905,902	667,157	2,460,944	4,034,003	100,850	111,211	2031
Rest of Texas	94,050	69,215	601,224	764,488	19,112	21,254	2031
Texas Total	999,952	736,372	3,062,167	4,798,491	119,962	132,082	2031
Louisiana (LA)							
LA-1	127,525	54,867	164,755	347,147	8,679	9,619	2031
LA-2	188,339	83,006	486,204	757,550	18,939	21,238	2031
LA-3	228,284	135,505	954,376	1,318,164	32,954	36,791	2031
LA-4	181,901	95,921	430,986	708,808	17,720	19,610	2031
All Louisiana EIA's	726,049	369,299	2,036,320	3,131,669	78,292	87,243	2031
Rest of Louisiana	129,096	47,860	269,970	446,926	11,173	12,234	2031
Louisiana Total	855,145	417,159	2,306,291	3,578,595	89,465	99,417	2031
Florida (FL)							
FL-1	16,627	8,441	36,556	61,624	1,541	1,728	2031
FL-2	32,225	12,885	78,288	123,398	3,085	3,459	2031
FL-3	27,777	16,690	91,469	135,935	3,398	3,808	2031
FL-4	22,461	14,822	66,806	104,089	2,602	2,936	2031
All Florida EIA's	99,090	52,837	273,119	425,046	10,626	11,931	2031
Rest of Florida	37,918	28,184	129,376	195,479	4,887	5,460	2031
Florida Total	137,008	81,021	402,495	620,524	15,513	17,391	2031
Alabama (AL)							
AL-1	28,460	14,826	116,359	159,645	3,991	4,463	2031
Rest of Alabama	83,308	46,501	217,520	347,328	8,683	9,618	2031
Alabama Total	111,768	61,327	333,879	506,973	12,674	14,080	2031
Mississippi (MS)							
MS-1	25,439	7,930	70,127	103,496	2,587	3,086	2031
Rest of Mississippi	71,899	26,450	162,419	260,767	6,519	7,350	2031
Mississippi Total	97,338	34,380	232,545	364,263	9,107	10,437	2031
Total All EIA's*	1,784,941	1,112,049	4,956,868	7,853,858	196,346	217,934	2031
Total 5 Gulf Coast States*	2,201,210	1,330,259	6,337,377	9,868,846	246,721	273,406	2031
Rest of U.S.	320,104	392,699	2,516,788	3,229,591	80,740	89,122	2031
Total U.S.	2,521,314	1,722,957	8,854,165	13,098,437	327,461	361,431	2031

Notes: Totals may not sum due to rounding.
* Adds peak from different years.

Source: Employment output from BOEMRE's economic impact model (MAG-PLAN) (Kaplan et al., 2011).

Table 4-59

Peak Population Projected from the Cumulative OCS Programs as a Percent of Total Population

Economic Impact Area	Cumulative Low				Cumulative High			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	16,672	2030	2,511,010	0.7%	25,916	2031	2,548,500	1.0%
TX-2	6,332	2031	794,430	0.8%	10,422	2031	794,430	1.3%
TX-3	171,858	2030	8,421,370	2.0%	252,878	2031	8,534,580	3.0%
Louisiana (LA)								
LA-1	15,467	2031	377,170	4.1%	24,914	2031	377,170	6.6%
LA-2	35,074	2030	709,790	4.9%	55,008	2031	716,050	7.7%
LA-3	60,147	2030	1,411,830	4.3%	95,288	2031	1,426,340	6.7%
LA-4	31,946	2030	1,499,470	2.1%	50,790	2031	1,511,370	3.4%
Florida (FL)								
FL-1	2,646	2031	1,219,220	0.2%	4,476	2031	1,219,220	0.4%
FL-2	5,245	2031	852,480	0.6%	8,958	2031	852,480	1.1%
FL-3	5,820	2031	4,672,190	0.1%	9,863	2031	4,672,190	0.2%
FL-4	4,405	2031	7,975,380	0.1%	7,603	2031	7,975,380	0.1%
Alabama (AL)								
AL-1	6,797	2030	846,940	0.8%	11,559	2031	853,170	1.4%
Mississippi (MS)								
MS-1	4,747	2030	556,770	0.9%	7,994	2031	561,190	1.4%

Sources: Peak population output from BOEMRE's economic impact model (MAG-PLAN) (Kaplan et al., 2011).
Baseline population projections based on Woods & Poole Economics, Inc. (2010).

Table 4-60

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		

Sources: British Petroleum, 2010 and Kaplan et al., 2011.

Table 4-61

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 DWH Liquid Waste Collected	Percentage of Total DWH 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.

Table 4-62

Gulf Coast Claims Facility — *Deepwater Horizon* Claimant Data by State
(status report as of April 27, 2011)

Alabama Claimant Status	No. of Claimants
Total GCCF Claimants to Date (claimants may have one or more claim type)	73,197
1. Paid Claimants	29,957

State	Claims for Emergency or Final Payment (includes individual and business)	Number of Claims Paid	Amount Paid
Alabama	1. Removal and Cleanup Costs	40	$414,560
	2. Real or Personal Property	75	$676,538
	3. Lost Earnings or Profits	49,629	$725,729,536
	4. Loss of Subsistence Use of Natural Resources	11	$84,240
	5. Physical Injury/Death	25	$68,000
Alabama Total	Total to Date	49,780	$726,972,874

Florida Claimant Status	No. of Claimants
Total GCCF Claimants to Date (claimants may have one or more claim type)	176,001
1. Paid Claimants	75,303

State	Claims for Emergency or Final Payment (includes individual and business)	Number of Claims Paid	Amount Paid
Florida	1. Removal and Cleanup Costs	39	$520,629
	2. Real or Personal Property	66	$393,393
	3. Lost Earnings or Profits	124,617	$1,551,648,940
	4. Loss of Subsistence Use of Natural Resources	8	$131,975
	5. Physical Injury/Death	13	$201,107
Florida Total	Total to Date	124,743	$1,552,896,044

Louisiana Claimant Status	No. of Claimants
Total GCCF Claimants to Date (claimants may have one or more claim type)	203,460
1. Claimants Paid and Approved for Payment	62,541

State	Claims for Emergency or Final Payment (includes individual and business)	Number of Claims Paid	Amount Paid
Louisiana	1. Removal and Cleanup Costs	9	$157,165
	2. Real or Personal Property	71	$929,045
	3. Lost Earnings or Profits	106,206	$1,321,768,784
	4. Loss of Subsistence Use of Natural Resources	16	$130,464
	5. Physical Injury/ Death	29	$85,423
Louisiana Total	Total to Date	106,331	$1,323,070,881

Table 4-62. Gulf Coast Claims Facility — *Deepwater Horizon* Claimant Data by State, (status report as of April 27, 2011) (continued).

Mississippi Claimant Status	No. of Claimants
Total GCCF Claimants to Date (claimants may have one or more claim type)	55,334
1. Paid Claimants	15,868

State	Claims for Emergency or Final Payment (includes individual and business)	Number of Claims Paid	Amount Paid
Mississippi	1. Removal and Cleanup Costs	0	$0
	2. Real or Personal Property	32	$298,983
	3. Lost Earnings or Profits	26,918	$336,742,048
	4. Loss of Subsistence Use of Natural Resources	5	$37,189
	5. Physical Injury/ Death	11	$41,763
Mississippi Total	Total to Date	26,966	$337,119,983

Texas Claimant Status	No. of Claimants
Total GCCF Claimants to Date (claimants may have one or more claim type)	11,735
1. Paid Claimants	3,141

State	Claims for Emergency or Final Payment (includes Individual and Business)	Number of Claims Paid	Amount Paid
Texas	1. Removal and Cleanup Costs	1	$169,100
	2. Real or Personal Property	5	$55,000
	3. Lost Earnings or Profits	4,222	$153,429,443
	4. Loss of Subsistence Use of Natural Resources	0	$0
	5. Physical Injury/ Death	4	$14,000
Texas Total	Total to Date	4,232	$153,667,543

Source: Gulf Coast Claims Facility, 2011b.

Table 4-63

WPA Federally Listed Species to be Considered by State from the Fish and Wildlife Service

Species	Endangered Species Act Status
Texas	
Attwater's greater prairie-chicken (*Tympanuchus cupido attwateri*)	E
Green sea turtle (*Chelonia mydas*)	T
Gulf Coast jaguarundi (*Herpailurus yagouaroundi cacomitli*)	E
Hawksbill sea turtle (*Eretmochelys imbricata*)	ECH
Kemp's Ridley sea turtle (*Lepidochelys kempii*)	E
Leatherback sea turtle (*Dermochelys coriacea*)	ECH
Loggerhead sea turtle (*Caretta caretta*)	T
Northern aplomado falcon (*Falco femoralis septentrionalis*)	E
Ocelot (*Leopardus pardalis*)	E
Piping plover (*Charadrius melodus*)	TCH
West Indian manatee (*Trichechus manatus*)	E
Whooping crane (*Grus americana*)	ECH
South Texas ambrosia (*Ambrosia cheiranthifolia*)	E
Texas prairie dawn-flower (*Hymenoxys texana*)	E
Texas ayenia (*Ayenia limitaris*)	E
Black lace cactus (*Echinocereus reichenbachii* var. *albertii*)	E
Slender rush-pea (*Hoffmannseggia tenella*)	E
Mountain plover (*Charadrius montanus*)	PT

Notes: E = endangered
ECH or TCH = endangered/threatened with critical habitat
PT = proposed threatened
T = threatened

Source: Smith, official communication, 2011.

Table 4-64

Projected Average Annual OCS Emissions Related to the CPA Proposed Action by Source (tons/year)

Source	Low - High Case		Emissions - Highest Annual (tons/yr)						
	NO_X	SO_X	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	2,470- 4,842	315-617	43-85	43-84	58-114	581-1138	128,528-252,020	5.2-10.3	1.1-2.2
Development/Production Well Drilling	1,347-2,610	172-333	24-46	23-45	32-61	317-613	70,098-135,859	2.9-5.0	0.6-1.2
Platform Installation and Removal	110-197	16-28.1	3.4-4.5	3.4-4.6	3.4-4.6	18-26	8,786-11,739	0.1-0.1	0.4-0.5
Pipeline Installation	517-1,540	88-261	20-58	20-58	20-58	107-320	34,958-104,157	0.4-1.2	1.5-4.5
Production Platforms	1,859-3,559	45-87	17-33	17-33	1,188-2,274	2,083-3987	205,104-392,628	4,972-9,518	3.0-5.6
Support Vessels	3,347-6,407	451-863	58-111	58-111	58-111	319-610	183,635-351,530	1.2-2.2	8.7-16.7
Helicopters	28-52.8	6.8-13.0	58-111.0	58-111	67-127.6	338-640	33,999-65,084	NA-NA	NA-NA
Tankers Loading	0.0-55	0.0-9	0.0-2.1	0.0-2.1	0.0-389	0.0-11	0.0- 3,711	0.0-0.04	0.0-0.16
Tankers in Transit	0.0-1,184	0.0-144	0.0-18	0.0-18	0.0-27	0.0-99	0.0- 58,490	0.0-0.4	0.0-3
Tankers Unloading	0.0- 55	0.0-9	0.0-2.1	0.0-2.1	0.0-197	0.0-11	0.0-3,711	0.0-0.04	0.0-0.16
Barge Loading	82.5-160.4	14.0-272	3.1-6.1	3.1-6.1	202.3-393.2	17.1-33.3	5,581 -10,847	0.06-0.12	0.2-0.5
Barge Transit	685.0-1331	83.0-161	10.4-20	10.4-20	78.9-153	57.1-111	33,834- 65,756	0.21-0.40	1.6-3
Barge Unloading	82.5-160	14.0-272	3.1-6.1	3.1-6.1	102.7-200	17.1-33	5,581 -10,847	0.06-0.12	0.2-0.5
Total	10,527-20,502	1,204-2,212	240-451	239-449	1,809-3,140	3,854-7,351	710,105-1,316,728	4,982-9,536	17-31

NA = not available

Note: Uses 50 years of data including the *Year 2008 Gulfwide Emission Inventory Study*. Most data are from the last 20 years.

Source: Wilson et al., 2010.

Table 4-65

Navigation Canals and Service Bases Associated with the OCS Activities

Canal Name	Service Bases
Atchafalaya River, LA	Morgan City
Baptiste Collette Bayou channe1, LA	Venice
Bayou Lafourche Cutoff, LA	Fourchon
Calcasieu Ship Channe1, LA	Cameron
Freshwater Bayou Channe1, LA	Intracoastal City
Houma Navigation Canal, LA	Houma
Main Pass Channel, LA	Venice
Mississippi River Mouth Pass, LA	Venice
Pass a Loutre Channel, LA	Venice
South Pass Channe1, LA	Venice
Southwest Pass Channe1, LA	Venice
Tiger Pass Channel, LA	Venice

Source: Thatcher et al., 2011.

Table 4-66

Mississippi Department of Marine Resources: Summary of Fish Kills Observed along the Gulf Coast

Date	Area	Dissolved Oxygen	Fish
May 5, 2010	Bayou Chicot, LA	<1.0 mg/L	3.3 million juvenile menhaden*
May 5, 2010	Lake Mars Boat Ramp, Belle Fontaine, MS	2 mg/L	1.9 million menhaden*
May 11-12, 2010	Mississippi beaches	5-5.7 mg/L	27 hardhead catfish
July 8, 2010	Bayou Caddy, MS	1.7 mg/L	97 with 11 species†
August 1, 2010	Long Beach Harbor, MS	NA	1,900 with 23 species‡
August 3, 2010	Mississippi Sound south of Deer Island	NA	500,000 menhaden* (broken net)
August 5, 2010	Pass Christian Harbor, MS	6.7 mg/L	NA

* Abundance of menhaden is an estimate from the kill site.
† Species include trout, croaker, sheepshead, mullet, flounder, drum, catfish, and pinfish.
‡ Species include brown shrimp, crabs, stingrays, kingfish, silver perch, shrimp, eel, lookdown, least puffer, lizardfish, cusk-eel, black cheek, tonguefish, bay whiff, and Atlantic spadefish.
NA = not available.

Source: Devers, official communication, 2010.

Table 4-67

Top Species Caught by Recreational Fishers in the Gulf Coast States

Number of Fish									
Species	2001	2002	2003	2004	2005	2006	2007	2008	2009
Atlantic Croaker	4,186,990	3,589,525	3,488,464	4,342,264	2,659,716	3,905,810	3,979,556	4,245,495	5,331,132
Black Drum	1,509,119	1,586,284	1,523,614	1,686,081	1,115,153	1,346,737	1,233,862	1,728,173	1,672,719
Blackfin Tuna	50,581	35,051	38,601	73,301	60,501	64,825	83,375	92,763	91,581
Cobia	175,045	163,606	127,512	125,923	108,746	108,656	117,448	161,636	88,721
Dolphins	555,466	364,917	609,001	434,879	316,110	315,264	430,367	368,457	251,429
Gag	2,386,672	2,996,920	3,878,651	4,197,440	2,938,891	2,084,588	3,254,196	4,746,177	2,924,329
Gray Snapper	3,511,496	3,798,482	6,073,935	4,530,800	5,851,190	4,039,090	5,571,680	7,669,142	4,401,510
Great Amberjack	477,424	315,674	346,070	254,283	201,443	161,534	199,429	245,344	207,226
King Mackerel	575,699	488,142	398,234	447,247	380,793	967,378	429,562	376,508	596,232
Little Tuny	265,456	423,424	197,927	362,243	153,204	293,337	333,310	193,546	179,928
Pinfishes	14,675,911	11,664,212	8,848,476	13,813,893	10,274,164	10,324,881	11,762,014	15,942,884	11,591,996
Red Drum	8,261,019	7,351,899	8,587,461	8,387,639	7,492,498	9,838,039	9,030,204	9,700,431	8,063,967
Red Grouper	1,880,567	2,197,298	2,298,287	3,632,743	1,862,289	1,012,572	1,198,064	3,312,054	3,410,731
Red Snapper	2,654,554	3,196,853	2,934,322	3,217,643	2,732,425	3,527,145	3,872,259	2,624,982	2,910,337
Sand Seatrout	4,342,805	4,129,064	4,062,981	3,326,749	2,524,347	4,334,134	4,587,006	5,853,369	6,502,913
Sheepshead	3,126,988	3,253,252	3,945,716	4,669,176	3,961,753	2,992,718	2,397,513	3,229,301	3,189,143
Southern Flounder	902,531	622,566	911,039	917,938	692,293	738,351	802,929	691,132	757,326
Southern Kingfish	2,660,631	1,404,170	1,733,446	2,206,406	1,988,897	1,848,665	1,608,861	1,727,889	1,670,001
Spanish Mackerel	4,321,962	3,882,193	3,715,281	4,303,273	2,518,250	4,946,966	3,817,443	4,132,207	2,988,112
Spotted Seatrout	20,582,815	22,664,920	28,785,103	28,851,638	29,679,185	36,435,823	30,611,531	32,564,976	29,352,993
Striped Mullet	2,293,741	1,340,382	1,866,563	1,257,205	1,323,021	1,303,076	1,162,019	1,231,121	969,123
White Grunt	6,779,775	5,529,179	4,831,100	5,133,524	3,687,435	1,694,738	2,157,816	4,036,236	2,490,431
Pounds									
Species	2001	2002	2003	2004	2005	2006	2007	2008	2009
Atlantic Croaker	677,890	287,934	490,887	306,179	280,489	553,449	600,690	598,106	508,967
Black Drum	2,341,032	2,531,258	2,857,730	3,057,965	1,922,411	2,531,999	2,276,953	2,907,574	2,870,621
Blackfin Tuna	526,547	294,526	580,484	830,021	525,045	863,090	286,572	868,698	660,264
Cobia	1,129,714	791,793	1,101,782	1,227,464	1,208,989	1,072,033	1,012,921	913,566	534,810
Dolphins	2,496,877	2,227,922	2,530,400	2,011,021	1,222,221	1,183,392	2,028,360	1,327,670	1,358,031
Gag	3,854,869	3,781,229	3,278,245	4,693,183	3,510,799	1,936,492	2,534,137	3,071,762	1,594,303
Gray Snapper	1,412,589	1,324,563	1,893,108	2,044,198	1,964,576	1,975,178	1,512,298	2,065,549	1,604,298
Great Amberjack	1,153,786	1,847,882	2,416,947	2,251,265	1,358,653	1,282,616	989,630	1,213,319	1,484,002
King Mackerel	2,865,226	3,043,569	2,763,371	2,434,372	1,635,507	3,374,852	2,606,005	1,894,691	3,324,003
Little Tunny	587,429	873,813	590,683	1,108,632	310,877	619,746	813,722	385,382	578,719
Pinfishes	1,560,872	1,677,357	1,739,776	3,811,171	1,215,008	742,368	1,683,034	3,510,949	2,831,692
Red Drum	13,419,400	11,575,766	13,113,186	14,290,334	10,242,490	14,215,737	13,988,083	13,910,457	11,898,383
Red Grouper	1,415,307	1,744,180	1,359,015	3,235,764	1,431,359	980,311	1,039,597	896,377	926,111
Red Snapper	3,737,264	4,369,698	3,921,340	4,162,485	3,322,074	3,232,025	3,769,388	3,128,771	3,613,267
Sand Seatrout	1,905,500	1,723,872	1,556,192	1,121,936	879,417	1,557,953	1,701,233	1,930,689	2,389,301
Sheepshead	4,385,765	3,775,195	5,002,901	6,487,492	5,288,789	4,013,009	3,836,123	4,670,992	4,388,254
Southern Flounder	1,082,858	630,928	823,083	834,794	645,835	780,468	810,986	749,674	851,999
Southern Kingfish	993,027	581,779	683,569	783,204	657,967	616,415	608,426	629,250	710,651
Spanish Mackerel	3,549,609	3,202,118	2,614,570	2,907,069	1,583,811	2,655,099	2,542,007	2,788,369	1,962,775
Spotted Seatrout	12,514,780	9,684,768	11,881,531	11,880,671	11,761,193	18,057,746	13,817,897	15,180,141	14,500,754
Striped Mullet	2,330,227	1,523,427	2,194,545	1,525,980	1,536,234	1,600,983	1,245,425	1,418,025	900,037
White Grunt	2,352,568	2,019,945	1,785,777	1,751,156	1,602,724	680,403	701,343	1,325,970	1,013,062

Notes: (1) Fish that are released alive are included in the landings data but not in the weight data.
(2) This table presents the sum of fishing data for Louisiana, Mississippi, Alabama, and West Florida.

Source: USDOC, NMFS, 2011b.

Table 4-68

Percentage of Species Landings that are Ocean Based

Number of Fish									
Species	2001	2002	2003	2004	2005	2006	2007	2008	2009
Atlantic Croaker	14.44	10.97	13.76	27.27	10.77	11.41	12.42	6.85	5.54
Black Drum	10.11	9.76	11.49	11.39	16.10	9.48	4.41	4.66	5.41
Blackfin Tuna	100.00	100.00	100.00	100.00	96.64	100.00	100.00	100.00	100.00
Cobia	64.14	72.50	74.56	79.25	83.60	86.83	81.25	73.28	71.72
Dolphins	98.92	100.00	100.00	100.00	100.00	99.72	99.49	99.21	100.00
Gag	82.69	75.01	76.77	81.08	83.59	71.17	63.72	71.40	61.45
Gray Snapper	49.48	32.43	41.52	42.93	36.45	49.40	40.26	48.61	32.00
Great Amberjack	96.21	99.63	99.51	99.74	99.18	98.85	100.00	99.44	100.00
King Mackerel	97.34	96.94	99.20	95.87	93.48	62.50	94.85	93.83	93.00
Little Tunny	97.84	96.08	99.76	99.80	99.10	92.75	87.64	86.66	87.22
Pinfishes	36.89	31.37	48.33	30.53	43.72	44.88	26.31	37.73	24.59
Red Drum	18.34	13.25	14.44	13.50	21.46	17.50	12.96	12.48	7.45
Red Grouper	98.33	99.38	98.22	97.36	98.12	98.60	97.14	91.04	83.08
Red Snapper	99.32	99.67	99.49	99.20	98.38	98.21	97.97	96.82	98.39
Sand Seatrout	22.81	14.26	11.90	24.40	19.24	23.00	21.26	13.97	12.28
Sheepshead	30.22	23.09	19.56	22.49	24.68	28.70	32.45	19.91	13.34
Southern Flounder	14.11	15.62	5.44	15.59	12.10	8.26	12.23	6.21	4.68
Southern Kingfish	48.30	43.11	33.38	29.19	26.33	39.34	28.73	36.84	18.05
Spanish Mackerel	69.03	53.39	68.10	73.05	63.10	67.63	55.73	70.40	51.93
Spotted Seatrout	23.52	25.12	20.03	18.99	22.97	20.61	23.59	17.20	15.36
Striped Mullet	18.47	13.28	13.20	13.04	28.14	38.07	15.12	21.97	9.98
White Grunt	79.12	86.20	85.07	87.96	91.14	90.42	78.79	85.87	69.51
Pounds									
Species/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Atlantic Croaker	10.99	12.90	18.98	11.59	3.21	6.63	8.58	5.00	2.37
Black Drum	16.37	21.47	10.60	17.86	9.56	7.15	6.12	6.30	12.54
Blackfin Tuna	100.00	100.00	100.00	100.00	91.49	100.00	100.00	100.00	100.00
Cobia	87.14	80.65	84.22	92.18	95.30	92.92	87.02	87.07	75.04
Dolphins	99.00	100.00	100.00	100.00	100.00	100.00	100.00	99.57	100.00
Gag	97.52	96.43	95.77	96.10	93.16	94.32	89.21	90.92	81.40
Gray Snapper	75.80	75.27	74.21	80.80	84.10	75.51	70.68	71.76	59.57
Great Amberjack	100.00	100.00	99.97	100.00	99.71	100.00	100.00	100.00	100.00
King Mackerel	99.08	96.50	99.46	98.06	98.58	82.52	96.19	97.61	96.20
Little Tunny	100.00	100.00	99.58	99.98	100.00	95.96	70.54	94.12	92.99
Pinfishes	41.84	34.38	56.40	26.93	48.10	54.05	19.22	25.85	22.79
Red Drum	18.82	15.84	16.08	19.52	15.07	15.14	14.94	10.93	7.22
Red Grouper	99.30	99.73	99.71	99.86	100.00	100.00	98.89	97.43	98.25
Red Snapper	99.85	99.83	99.81	98.32	99.45	98.97	96.89	98.31	98.53
Sand Seatrout	21.90	13.65	11.51	26.39	20.30	24.21	19.14	14.25	15.06
Sheepshead	43.70	30.20	26.82	26.65	34.75	39.45	47.43	23.60	13.88
Southern Flounder	16.88	16.23	6.27	14.58	9.26	7.55	9.00	6.98	3.98
Southern Kingfish	51.32	41.90	28.09	27.11	30.90	33.24	28.64	42.04	15.56
Spanish Mackerel	70.72	63.52	70.76	76.73	69.40	67.47	61.28	68.15	56.71
Spotted Seatrout	25.10	28.31	16.25	17.92	20.36	15.85	19.12	14.32	14.31
Striped Mullet	24.07	10.45	7.14	14.07	22.48	31.63	12.10	27.41	6.60
White Grunt	89.48	90.69	91.05	89.34	93.79	94.64	83.12	90.31	83.39

Notes: (1) Fish that are released alive are included in the landings data but not in the weight data.
(2) This table presents the sum of fishing data for Louisiana, Mississippi, Alabama, and West Florida.
(3) The NMFS divides fishing data into inland, State, and Federal categories. Ocean based is defined as the sum of State and Federal categories.

Source: USDOC, NMFS, 2011b.

Table 4-69

Recreational Fishing Participation

State	Coastal	Noncoastal	Out of State	Total
West Florida	1,551,478	0	1,670,603	3,222,081
East Florida	1,098,575	0	1,741,339	2,839,914
Alabama	205,365	151,379	208,775	565,519
Mississippi	125,048	36,496	50,328	211,872
Louisiana	668,576	108,086	139,120	915,782

Source: USDOC, NMFS, 2011c.

State	Resident	Nonresident	Total
Florida	1,881	885	2,767
Texas	2,308	218	2,527
Alabama	600	206	806
Mississippi	465	80	546
Louisiana	590	112	702

Source: USDOI, FWS and USDOC, Census Bureau, 2006.

Table 4-70

Angler Trips in the Gulf of Mexico by Location and Mode in 2009

State	Area	Number of Trips	% State Total
Alabama	Shore Ocean (<3 nmi)	354,043	20.6
	Shore Inland	407,982	23.8
	Charter Ocean (<3 nmi)	9228	0.5
	Charter Ocean (>3 nmi)	36672	2.1
	Charter Inland	10759	0.6
	Private/Rental Ocean (<3 nmi)	154301	9.0
	Private/Rental Ocean (>3 nmi)	165012	9.6
	Private/Rental Inland	579033	33.7
	Total	1,717,030	
West Florida	Shore Ocean (<9 nmi)	2,511,933	16.2
	Shore Inland	3,942,920	25.4
	Charter Ocean (<9 nmi)	195,688	1.3
	Charter Ocean (>9 nmi)	259,622	1.7
	Charter Inland	112,007	0.7
	Private/Rental Ocean (<9 nmi)	2,602,581	16.8
	Private/Rental Ocean (>9 nmi)	616,371	4.0
	Private/Rental Inland	5,276,236	34.0
	Total	15,517,358	
Louisiana	Shore Ocean (<3 nmi)	37,324	0.9
	Shore Inland	731,676	18.3
	Charter Ocean (<3 nmi)	3,283	0.1
	Charter Ocean (>3 nmi)	18,031	0.5
	Charter Inland	135,654	3.4
	Private/Rental Ocean (<3 nmi)	75,482	1.9
	Private/Rental Ocean (>3 nmi)	102,196	2.6
	Private/Rental Inland	2,896,326	72.4
	Total	3,999,972	
Mississippi	Shore Ocean (<3 nmi)	330	0.0
	Shore Inland	307,856	29.0
	Charter Ocean (<3 nmi)	2,831	0.3
	Charter Ocean (>3 nmi)	330	0.0
	Charter Inland	7,680	0.7
	Private/Rental Ocean (<3 nmi)	18,602	1.8
	Private/Rental Ocean (>3 nmi)	26,095	2.5
	Private/Rental Inland	698,752	65.8
	Total	1,062,476	
Gulf Total	Shore Ocean (<3 nmi)	2,903,630	13.0
	Shore Inland	5,390,434	24.2
	Charter Ocean (<3 nmi)	211,030	0.9
	Charter Ocean (>3 nmi)	314,655	1.4
	Charter Inland	266,100	1.2
	Private/Rental Ocean (<3 nmi)	2,850,966	12.8
	Private/Rental Ocean (>3 nmi)	909,674	4.1
	Private/Rental Inland	9,450,347	42.4
	Total	22,296,836	

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, 2011c.

Table 4-71

Angler Trips in the Gulf of Mexico in 2009 and 2010

	2009					
	Jan/Feb	Mar/April	May/June	July/Aug	Sep/Oct	Nov/Dec
Total Trips						
Alabama	134,887	309,545	454,940	405,356	129,914	282,388
Florida	2,205,141	2,588,254	3,963,196	3,422,240	1,008,840	2,329,685
Louisiana	583,195	561,112	1,058,162	838,820	463,370	495,313
Mississippi	127,336	148,993	222,623	251,448	160,440	151,636
Total	3,050,559	3,607,904	5,698,921	4,917,864	1,762,564	3,259,022
Inland						
Alabama	90,030	201,215	271,504	225,383	56,918	152,725
Florida	1,432,011	1,579,247	2,227,167	2,077,674	603,310	1,411,755
Louisiana	568,870	552,088	990,311	718,606	443,965	489,816
Mississippi	121,012	145,411	201,851	241,075	155,102	149,837
Total	2,211,923	2,477,961	3,690,833	3,262,738	1,259,295	2,204,133
State						
Alabama	44,218	93,732	80,117	114,938	55,200	129,367
Florida	662,919	927,192	1,423,612	1,105,167	358,351	832,960
Louisiana	5,302	1,728	38,986	61,425	8,648	--
Mississippi	1,150	273	7,627	10,191	723	1,799
Total	713,589	1,022,925	1,550,342	1,291,721	422,922	964,126
Federal						
Alabama	639	14,597	103,320	65,035	17,797	296
Florida	263,740	242,654	711,964	510,244	127,099	242,804
Louisiana	9,023	7,296	28,865	58,788	10,757	5,497
Mississippi	5,175	3,309	13,144	182	4,615	--
Total	278,577	267,856	857,293	634,249	160,268	248,597

	2010					
	Jan/Feb	Mar/April	May/June	July/Aug	Sep/Oct	Nov/Dec
Total Trips						
Alabama	85,222	280,259	397,067	356,860	466,499	220,721
Florida	1,752,419	1,932,173	3,496,514	3,070,278	1,964,296	1,750,894
Louisiana	367,455	561,920	923,066	590,073	743,255	581,850
Mississippi	90,498	177,568	337,034	160,719	319,407	140,642
Total	2,295,594	2,951,920	5,153,681	4,177,930	3,493,457	2,694,107
Inland						
Alabama	55,475	148,705	239,701	174,298	146,222	73,482
Florida	1,440,253	1,300,252	2,092,628	1,956,212	1,246,555	1,217,073
Louisiana	356,714	548,866	901,637	571,535	726,086	577,373
Mississippi	89,849	174,346	329,306	160,719	318,865	135,763
Total	1,942,291	2,172,169	3,563,272	2,862,764	2,437,728	2,003,691
State						
Alabama	29,187	115,547	117,122	182,207	275,313	124,292
Florida	241,036	543,613	1,169,724	946,296	620,487	458,061
Louisiana	7,045	11,019	15,061	11,450	14,675	2,577
Mississippi	649	3,088	7,728	--	77	1,334
Total	277,917	673,267	1,309,635	1,139,953	910,552	586,264
Federal						
Alabama	560	16,007	40,244	356	44,964	22,947
Florida	172,580	218,539	611,151	381,003	202,870	159,444
Louisiana	3,697	2,034	6,369	7,089	2,494	1,900
Mississippi	--	134	--	--	464	3,544
Total	176,837	236,714	657,764	388,448	250,792	187,835

Source: USDOC, NMFS, 2011c.

Table 4-72

Fish Species Caught by Recreational Anglers during Certain Months of 2009 and 2010

Species	2009						2010					
	Jan/Feb	Mar/April	May/June	July/Aug	Sep/Oct	Nov/Dec	Jan/Feb	Mar/April	May/June	July/Aug	Sep/Oct	Nov/Dec
Panel A: Number of Fish												
Atlantic Croaker	145,458	809,858	1,816,279	1,625,287	685,246	249,005	51,027	388,778	1,964,697	1,051,333	1,351,938	198,446
Black Drum	161,376	164,735	325,061	224,853	363,170	433,524	226,596	226,228	371,071	278,193	221,827	294,224
Blackfin Tuna	27,354	4,581	3,530	26,771	27,981	1,364	952	1,874	4,482	13,373	6,188	505
Cobia	584	4,475	40,360	34,150	7,226	1,925	853	13,984	28,806	15,184	8,708	1,948
Dolphins	12,011	14,355	130,214	84,491	9,551	808	2,069	19,299	130,020	25,707	9,024	1,787
Gag	395,418	296,874	811,646	478,649	168,920	772,821	223,793	211,989	621,248	364,634	441,585	432,167
Gray Snapper	485,160	635,363	934,055	1,451,321	346,088	549,524	311,069	218,729	401,038	711,077	372,027	240,627
Great Amberjack	31,396	12,326	104,533	45,653	11,093	2,225	68,419	54,285	147,476	42,008	31,216	25,753
King Mackerel	19,359	63,883	202,625	188,375	79,194	42,795	5,482	29,454	144,932	40,312	62,942	15,769
Little Tunny	19,291	9,276	32,635	38,169	20,699	59,857	3,895	7,919	15,266	50,873	50,270	43,849
Pinfishes	1,371,965	1,391,786	2,470,196	4,232,636	876,435	1,248,979	532,642	699,732	4,011,772	3,172,949	2,576,343	1,251,918
Red Drum	982,472	747,513	1,361,522	1,484,450	1,395,057	2,092,954	925,670	1,210,050	1,602,272	1,464,815	1,961,171	1,681,463
Red Grouper	437,521	250,878	1,198,225	691,905	284,875	547,327	58,460	139,033	754,056	391,949	490,688	519,988
Red Snapper	84,572	106,800	1,458,523	1,018,133	225,353	16,956	161,071	126,029	625,697	174,676	337,394	235,218
Sand Seatrout	269,556	638,973	2,068,415	1,612,595	1,074,715	838,658	110,964	638,583	1,868,132	863,475	1,920,085	850,658
Sheepshead	1,272,356	901,817	135,120	169,281	75,335	635,235	743,502	999,001	180,950	110,798	162,605	795,018
Southern Flounder	36,231	57,573	143,744	213,087	146,398	160,292	18,575	85,933	271,472	317,392	213,433	98,797
Southern Kingfish	76,964	289,755	500,087	405,015	237,960	160,220	133,002	149,914	502,725	132,009	308,206	74,843
Spanish Mackerel	81,393	472,775	1,059,242	612,279	335,653	426,770	12,251	582,650	684,299	1,128,472	1,178,397	396,399
Spotted Seatrout	3,771,209	2,719,521	8,622,412	5,350,897	3,355,867	5,533,087	1,531,203	1,701,972	5,628,670	4,504,846	4,794,022	5,786,862
Striped Mullet	198,193	31,379	109,002	322,672	231,940	75,937	31,652	8,309	261,351	413,694	423,089	239,669
White Grunt	518,784	236,420	448,748	554,624	205,154	526,702	156,702	244,049	722,961	600,624	382,951	545,870

Table 4-72. Fish Species Caught by Recreational Anglers during Certain Months of 2009 and 2010 (continued).

Species	2009						2010					
	Jan/Feb	Mar/April	May/June	July/Aug	Sep/Oct	Nov/Dec	Jan/Feb	Mar/April	May/June	July/Aug	Sep/Oct	Nov/Dec
Panel B: Pounds												
Atlantic Croaker	11,715	57,628	173,870	166,893	84,985	13,878	12,017	24,299	201,948	108,541	151,061	16,310
Black Drum	272,586	352,421	531,320	546,397	579,195	588,701	297,504	664,160	311,534	388,834	351,252	655,910
Blackfin Tuna	202,746	21,076	30,382	265,762	114,840	25,461	10,769	0	72,011	76,996	51,976	4,632
Cobia	0	65,580	133,791	297,808	35,571	2,057	15,587	192,911	174,999	88,695	52,503	25,851
Dolphins	77,512	90,040	630,635	476,560	76,145	7,141	9,791	46,760	357,130	115,025	75,320	15,053
Gag	87,005	146,676	566,695	246,203	52,189	495,532	161,449	189,119	549,591	177,792	187,883	356,367
Gray Snapper	152,724	162,960	446,707	618,699	142,580	80,631	31,164	69,081	187,287	282,365	153,513	51,206
Great Amberjack	187,900	73,076	693,653	459,602	69,771	0	75,730	323,241	552,321	105,719	275,498	74,822
King Mackerel	111,522	214,979	983,633	1,136,665	586,283	290,919	37,714	166,044	963,547	208,815	498,634	101,621
Little Tunny	68,459	41,731	87,565	165,513	58,678	156,776	11,684	43,415	39,482	211,672	86,817	36,881
Pinfishes	258	313,523	747,119	1,375,430	197,133	198,231	745,873	205,354	346,239	512,124	64,941	224,752
Red Drum	817,402	1,345,542	2,748,252	2,309,682	2,337,423	2,340,081	1,187,477	2,311,909	2,322,872	2,103,290	3,037,917	2,155,909
Red Grouper	21,369	53,245	307,916	411,885	43,748	87,946	12,934	36,363	207,175	145,356	150,563	86,484
Red Snapper	0	0	1,683,450	1,929,816	0	0	0	0	402,293	288,880	495,610	445,371
Sand Seatrout	148,892	220,669	765,417	492,922	365,977	395,424	53,887	233,857	645,370	388,398	799,220	385,066
Sheepshead	1,685,580	1,480,944	201,108	222,947	97,701	699,974	664,292	1,477,876	201,121	60,615	169,931	932,416
Southern Flounder	29,987	59,601	147,221	233,972	165,012	216,205	13,750	105,830	286,926	334,782	266,959	100,680
Southern Kingfish	39,828	125,402	216,637	228,593	34,828	65,362	68,369	57,747	159,931	47,677	85,336	36,848
Spanish Mackerel	109,864	320,961	683,805	431,326	201,492	215,328	8,170	353,254	453,978	497,642	1,053,287	245,209
Spotted Seatrout	1,445,014	1,134,580	5,358,179	2,776,994	1,413,162	2,372,826	475,179	808,557	3,357,449	1,816,288	2,047,965	2,954,113
Striped Mullet	124,267	4,899	67,245	330,619	254,422	118,588	44,804	7,551	267,067	686,146	827,871	316,087
White Grunt	272,297	115,689	140,164	180,879	51,826	252,208	91,019	119,101	227,634	252,521	150,834	190,846

Source: USDOC, NMFS, 2011c.

Table 4-73

Deepwater Horizon Damage Claims in Florida

Panel A: Individual Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	2,874	31,078,873.96
Food, Beverage, and Lodging	56,051	367,552,780.80
Multiple Industry/Business Types	4,861	42,734,343.43
No Industry Designation	334	2,883,323.65
Rental Property	2,380	17,947,146.90
Retail, Sales, and Service	26,051	178,475,908.04
Seafood Processing and Distribution	629	5,516,938.72
Tourism and Recreation	2,288	16,112,294.55
Total	95,468	662,301,610.05
Panel B: Business Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	4,475	123,006,620.19
Food, Beverage, and Lodging	3,238	178,927,026.30
Multiple Industry/Business Types	335	6,240,072.80
No Industry Designation	573	11,999,545.22
Rental Property	12,566	226,613,506.50
Retail, Sales, and Service	12,228	355,753,091.11
Seafood Processing and Distribution	262	18,331,918.44
Tourism and Recreation	961	36,998,307.23
Total	34,638	957,870,087.79

Source: Gulf Coast Claims Facility, 2011c.

Table 4-74

Deepwater Horizon Damage Claims in Mississippi

Panel A: Individual Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	1,424	17,971,648.68
Food, Beverage, and Lodging	9,173	52,124,295.75
Multiple Industry/Business Types	688	6,427,488.76
No Industry Designation	65	528,463.29
Rental Property	78	637,700.00
Retail, Sales, and Service	9,114	63,827,739.88
Seafood Processing and Distribution	1,088	10,333,102.76
Tourism and Recreation	453	2,084,984.32
Total	22,083	153,935,423.44
Panel B: Business Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	1,293	49,453,485.98
Food, Beverage, and Lodging	610	28,486,019.64
Multiple Industry/Business Types	75	2,220,722.61
No Industry Designation	84	1,528,956.60
Rental Property	825	19,126,755.85
Retail, Sales, and Service	2,932	86,674,554.75
Seafood Processing and Distribution	147	9,891,721.03
Tourism and Recreation	76	2,428,948.54
Total	6,042	199,811,165.00

Source: Gulf Coast Claims Facility, 2011c.

Table 4-75

Deepwater Horizon Damage Claims in Louisiana

Panel A: Individual Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	4,546	61,682,265.31
Food, Beverage, and Lodging	47,670	308,588,964.22
Multiple Industry/Business Types	2,175	21,633,499.94
No Industry Designation	333	2,642,203.96
Rental Property	135	1,208,067.22
Retail, Sales, and Service	29,033	213,566,446.83
Seafood Processing and Distribution	3,330	31,332,493.16
Tourism and Recreation	951	6,850,404.82
Total	88,173	647,504,345.46
Panel B: Business Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	7,319	269,605,207.26
Food, Beverage, and Lodging	2,442	93,164,356.16
Multiple Industry/Business Types	215	7,442,278.45
No Industry Designation	153	3,164,537.80
Rental Property	1,277	22,722,073.55
Retail, Sales, and Service	8,838	232,889,259.53
Seafood Processing and Distribution	564	79,389,702.17
Tourism and Recreation	159	5,113,159.28
Total	20,967	713,490,574.20

Source: Gulf Coast Claims Facility, 2011c.

Table 4-76

Deepwater Horizon Damage Claims in Alabama

Panel A: Individual Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	1,858	22,519,133.26
Food, Beverage, and Lodging	13,096	87,420,827.79
Multiple Industry/Business Types	1,176	11,261,564.35
No Industry Designation	81	639,891.87
Rental Property	1,203	9,231,595.15
Retail, Sales, and Service	13,540	110,540,189.36
Seafood Processing and Distribution	2,410	20,005,526.20
Tourism and Recreation	397	3,403,973.53
Total	33,761	265,022,701.51
Panel B: Business Claims		
Industry	No. of Claims	Amount Paid ($)
Fishing	1,224	41,742,620.26
Food, Beverage, and Lodging	1,008	55,186,365.91
Multiple Industry/Business Types	202	6,211,952.83
No Industry Designation	458	8,532,227.43
Rental Property	8,966	171,457,909.24
Retail, Sales, and Service	5,434	177,860,460.44
Seafood Processing and Distribution	253	16,878,074.46
Tourism and Recreation	243	15,413,745.67
Total	17,788	493,283,356.24

Source: Gulf Coast Claims Facility, 2011c.

Table 4-77

Shipwrecks in the Central Planning Area

Map Area	No. of Reported Wrecks	Historic Wrecks (verified)
Bay Marchand	3	1
Breton Sound	11	0
Chandeleur	8	0
East Cameron	49	1
Eugene Island	98	1
Ewing Bank	5	1
Green Canyon	15	2
Grand Isle	33	3
Lund	11	0
Mississippi Canyon	49	11
Mobile	56	2
Main Pass	65	0
South Pelto	16	0
Sabine Pass (LA)	15	0
South Marsh Island	33	1
South Pass	36	1
Ship Shoal	95	3
South Timbalier	90	2
Viosca Knoll	23	4
Vermilion	62	0
West Cameron	121	1
West Delta	62	0
Walker Ridge	3	0
Total	959	34

Table 4-78

Peak Population Projected from a CPA Proposed Action as a Percent of Total Population

Economic Impact Area	CPA Low				CPA High			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	1,355	2028	2,437,910	0.1%	3,944	2028	2,437,910	0.2%
TX-2	254	2015	667,230	0.0%	505	2018	692,310	0.1%
TX-3	11,023	2015	6,736,630	0.2%	20,314	2015	6,736,630	0.3%
Louisiana (LA)								
LA-1	1,150	2015	344,150	0.3%	2,205	2018	350,130	0.6%
LA-2	2,359	2015	617,100	0.4%	4,936	2028	697,460	0.7%
LA-3	4,156	2015	1,195,920	0.3%	8,228	2028	1,383,290	0.6%
LA-4	2,292	2015	1,322,960	0.2%	4,416	2018	1,357,450	0.3%
Florida (FL)								
FL-1	167	2015	975,020	0.0%	2,205	2018	1,023,220	0.2%
FL-2	333	2015	704,900	0.0%	4,936	2018	734,000	0.7%
FL-3	363	2015	3,879,470	0.0%	8,228	2018	4,035,620	0.2%
FL-4	264	2015	6,638,560	0.0%	4,416	2018	6,901,510	0.1%
Alabama (AL)								
AL-1	419	2028	834,600	0.1%	897	2028	834,600	0.1%
Mississippi (MS)								
MS-1	360	2028	548,050	0.1%	969	2028	548,050	0.2%

Sources: Peak employment output from BOEMRE's economic impact model (MAG-PLAN) (Kaplan et al., 2011). Baseline population projections based on Woods & Poole Economics, Inc. (2010).

Table 4-79

Low-Case Employment Projections for a CPA Proposed Action by Economic Impact Area

Economic Impact Area	Jobs (full- and part-time) from Industry Expenditure Effects						
	Total (40-year sum)				Average Annual	Peak Annual	Peak Year
	Direct	Indirect	Induced	Total			
Texas (TX)							
TX-1	1,000	464	2,832	4,296	107	523	2028
TX-2	405	139	953	1,497	37	98	2015
TX-3	13,330	10,650	38,948	62,928	1,573	4,256	2015
All Texas EIA's	14,735	11,254	42,733	68,721	1,718	4,553	2015
Rest of Texas	1,158	968	8,746	10,871	272	746	2015
Texas Total	15,893	12,221	51,479	79,593	1,990	5,299	2015
Louisiana (LA)							
LA-1	2,489	1,075	3,125	6,689	167	444	2015
LA-2	3,552	1,561	8,920	14,033	351	911	2015
LA-3	4,354	2,603	17,447	24,403	610	1,605	2015
LA-4	3,472	1,837	7,990	13,299	332	885	2015
All Louisiana EIA's	13,867	7,075	37,481	58,424	1,461	3,845	2015
Rest of Louisiana	2,452	899	4,838	8,189	205	574	2015
Louisiana Total	16,320	7,974	42,319	66,613	1,665	4,419	2015
Florida (FL)							
FL-1	260	135	549	944	24	64	2015
FL-2	500	203	1,163	1,867	47	128	2015
FL-3	436	268	1,359	2,063	52	140	2015
FL-4	349	236	965	1,550	39	102	2015
All Florida EIA's	1,546	842	4,037	6,424	161	435	2015
Rest of Florida	590	451	1,812	2,852	71	193	2015
Florida Total	2,135	1,293	5,848	9,277	232	628	2015
Alabama (AL)							
AL-1	425	231	1,702	2,358	59	162	2028
Rest of Alabama	1,316	747	3,316	5,379	134	371	2015
Alabama Total	1,741	978	5,018	7,737	193	531	2015
Mississippi (MS)							
MS-1	358	115	1,073	1,547	39	139	2028
Rest of Mississippi	1,128	423	2,527	4,078	102	286	2028
Mississippi Total	1,486	538	3,600	5,624	141	425	2028
Total All EIA's*	30,931	19,517	87,026	137,474	3,437	9,134	
Total 5 Gulf Coast States*	37,575	23,004	108,264	168,843	4,221	11,303	
Rest of U.S.	5,238	6,506	41,763	53,507	1,338	3,549	2015
Total U.S.	42,813	29,510	150,027	222,351	5,559	14,792	2015

Notes: Totals may not sum due to rounding.
* Adds peak from different years.

Source: Employment output from BOEMRE's economic impact model (MAG-PLAN) (Kaplan et al., 2011).

Table 4-80

High-Case Employment Projections for a CPA Proposed Action by Economic Impact Area

Economic Impact Area	Jobs (full- and part-time) from Industry Expenditure Effects						
	Total (40-year sum)				Average Annual	Peak Annual	Peak Year
	Direct	Indirect	Induced	Total			
Texas (TX)							
TX-1	2,705	1,218	6,638	10,561	264	1,523	2028
TX-2	906	312	2,107	3,325	83	195	2018
TX-3	27,133	21,387	78,964	127,485	3,187	7,843	2015
All Texas EIA’s	30,745	22,917	87,709	141,370	3,534	8,396	2018
Rest of Texas	2,484	2,057	19,340	23,882	597	1,467	2018
Texas Total	33,229	24,974	107,049	165,252	4,131	9,863	2018
Louisiana (LA)							
LA-1	5,432	2,414	6,975	14,821	371	851	2018
LA-2	7,885	3,432	19,262	30,578	764	1,906	2028
LA-3	9,751	5,887	38,081	53,719	1,343	3,177	2028
LA-4	7,641	4,057	17,427	29,124	728	1,705	2018
All Louisiana EIA’s	30,709	15,789	81,744	128,242	3,206	7,418	2028
Rest of Louisiana	5,290	1,922	10,453	17,665	442	1,126	2018
Louisiana Total	35,999	17,712	92,196	145,907	3,648	8,479	2018
Florida (FL)							
FL-1	577	298	1,246	2,121	53	130	2018
FL-2	1,122	452	2,652	4,226	106	260	2018
FL-3	969	586	3,093	4,648	116	285	2018
FL-4	787	525	2,239	3,551	89	211	2018
All Florida EIA’s	3,455	1,861	9,231	14,546	364	885	2018
Rest of Florida	1,325	997	4,277	6,599	165	404	2018
Florida Total	4,780	2,858	13,508	21,145	529	1,289	2018
Alabama (AL)							
AL-1	957	504	3,917	5,379	134	346	2028
Rest of Alabama	2,882	1,603	7,419	11,904	298	750	2018
Alabama Total	3,839	2,108	11,336	17,283	432	1,079	2018
Mississippi (MS)							
MS-1	936	291	2,518	3,745	94	374	2028
Rest of Mississippi	2,544	940	5,717	9,202	230	669	2028
Mississippi Total	3,480	1,232	8,235	12,947	324	1,043	2028
Total All EIA’s*	66,802	41,363	185,118	293,283	7,332	17,420	
Total 5 Gulf Coast States*	81,326	48,883	232,324	362,534	9,063	21,753	
Rest of U.S.	11,204	13,696	88,447	113,347	2,834	7,143	2018
Total U.S.	92,530	29,510	150,027	222,351	5,559	14,792	2018

Notes: Totals may not sum due to rounding.
* Adds peak from different years.

Source: Employment output from BOEMRE’s economic impact model (MAG-PLAN) (Kaplan et al., 2011).

Table 4-81

Peak Employment Projected from a CPA Proposed Action as a Percent of Total Employment

Economic Impact Area	CPA Low				CPA High			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	523	2028	1,119,070	0.0%	1,523	2028	1,119,070	0.1%
TX-2	98	2015	333,780	0.0%	195	2018	346,070	0.1%
TX-3	4,256	2015	3,938,830	0.1%	7,843	2015	3,938,830	0.2%
Louisiana (LA)								
LA-1	444	2015	189,620	0.2%	851	2018	195,460	0.4%
LA-2	911	2015	345,700	0.3%	1,906	2028	399,710	0.5%
LA-3	1,605	2015	715,330	0.2%	3,177	2028	839,520	0.4%
LA-4	885	2015	774,110	0.1%	1,705	2018	795,740	0.2%
Florida (FL)								
FL-1	64	2015	536,520	0.0%	130	2018	562,070	0.0%
FL-2	128	2015	355,620	0.0%	260	2018	368,980	0.1%
FL-3	140	2015	2,038,850	0.0%	285	2018	2,129,660	0.0%
FL-4	102	2015	3,643,040	0.0%	211	2018	3,812,150	0.0%
Alabama (AL)								
AL-1	162	2028	436,690	0.0%	346	2028	436,690	0.1%
Mississippi (MS)								
MS-1	139	2028	288,730	0.0%	374	2028	288,730	0.1%

Sources: Peak employment output from BOEMRE's economic impact model (MAG-PLAN) (Kaplan et al., 2011).
Baseline population projections based on Woods & Poole Economics, Inc. (2010).

Table 4-82

CPA Federally Listed Species to be Considered by State from the Fish and Wildlife Service

Species	Endangered Species Act Status
Louisiana	
Leatherback sea turtle (*Dermochelys comacea*)	E
Louisiana black bear (*Ursus americanus luteolus*)	TCH
Loggerhead sea turtle (*Caretta caretta*)	T
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E
Green sea turtle (*Chelonia mydas*)	T
West Indian manatee (*Trichechus manatus*)	E
Red-cockaded woodpecker (*Picoides borealis*)	E
Piping plover (*Charadrius melodus*)	TCH
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)	TCH
Gopher tortoise (*Gopherus polyphemus*)	T
Pallid sturgeon (*Scaphirynchus albus*)	E
Whooping crane (*Grus americana*)	PNEX
Hawksbill sea turtle (*Eretomochelys imbricata*)	E
Mississippi	
Alabama red-belly turtle (*Pseudemys alabamensis*)	E
Louisiana black bear (*Ursus americanus luteolus*)	T
Piping plover (*Charadrius melodus*)	TCH
Gopher tortoise (*Gopherus polyphemus*)	T
Ringed map turtle (*Graptemys oculifera*)	T
Green sea turtle (*Chelonia mydas*)	T
Leatherback sea turtle (*Dermochelys comacea*)	E
Loggerhead sea turtle (*Caretta caretta*)	T
Gulf sturgeon (*Acipenser oxyrhynchus desotoi*)	TCH
Inflated heelsplitter (*Potamilus inflatus*)	T
Louisiana quillwort (*Isoetes louisianensis*)	E
Mississippi gopher frog (*Rana capito sevosa*)	E, DPS
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E
Hawksbill sea turtle (*Eretomochelys imbricata*)	E
West Indian manatee (*Trichechus manatus*)	E
Pearl darter (*Percina aurora*)	C
Red-cockaded woodpecker (*Picoides borealis*)	E
Black pine snake (*Pituophis melanoleucus lodingi*)	C
Yellow-blotched map turtle (*Graptemys flavimaculata*)	T
Mississippi sandhill crane (*Grus canadensis pulla*)	ECH
Alabama	
Alabama beach mouse (*Peromyscus polionotus ammobates*)	ECH
Perdido Key beach mouse (*Peromyscus polionotus trissylepsis*)	ECH
West Indian manatee (*Trichechus manatus*)	E
Red-cockaded woodpecker (*Picoides borealis*)	E
Least tern (*Sterna antillarum*)	E
Piping plover (*Charadrius melodus*)	TCH
Alabama red-belly turtle (*Pseudemys alabamensis*)	E
Leatherback sea turtle (*Dermochelys comacea*)	E
Loggerhead sea turtle (*Caretta caretta*)	T
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E

Table 4-82. CPA Federally Listed Species to be Considered by State from the Fish and Wildlife Service (continued).

Species	Endangered Species Act Status
Alabama (continued)	
Green sea turtle (*Chelonia mydas*)	T
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)	TCH
Eastern indigo snake (*Drymarchon corais couperi*)	T
Hawksbill sea turtle (*Eretomochelys imbricata*)	E
Wood stork (*Mycteria Americana*)	E
Black pine snake (*Pituophis melanoleucus lodingi*)	C
Gopher tortoise (*Gopherus polyphemus*)	T
Inflated heelsplitter (*Potamilus inflatus*)	T
Florida	
Piping plover (*Charadrius melodus*)	TCH
Green sea turtle (*Chelonia mydas*)	T
Loggerhead sea turtle (*Caretta caretta*)	T
Gulf sturgeon (*Acipenser oxyrhynchus desotoi*)	TCH
Leatherback sea turtle (*Dermochelys comacea*)	E
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E
West Indian manatee (*Trichechus manatus*)	E
Hawksbill sea turtle (*Eretomochelys imbricata*)	E
Choctawhatchee beach mouse (*Peromyscus polionotus allophrys*)	ECH
Wood stork (*Mycteria Americana*)	E
Telephus spurge (*Euphorbia telephioides*)	T
Frosted flatwoods salamander (*Ambystoma cingulatum*)	T
Reticulated flatwoods salamander (*Ambystoma bishopi*)	E
Eastern indigo snake (*Drymarchon corais couperi*)	T

Notes: C = candidate
E = endangered
T = threatened
P = proposed threatened or endangered

DPS = distinct vertebrate population
ECH or TCH = endangered/threatened with critical habitat
NEX = nonessential experimental population

Source: Smith, official communication, 2011.

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APPENDICES

APPENDIX A

PHYSICAL AND ENVIRONMENTAL SETTINGS

A. PHYSICAL AND ENVIRONMENTAL SETTINGS

A.1. GEOGRAPHY AND GEOLOGY

General Physiographic Description

The present-day Gulf of Mexico (GOM) is a small ocean basin to the south of the North American continent measuring 1,600 kilometers (km) (990 miles [mi]) from east to west, 900 km (600 mi) north to south, and with a water-surface area of more than 1.5 million km^2 (371 million acres [ac]) (Moretzsohn et al., 2011). The greatest water depth is approximately 3,700 meters (m) (12,139 feet [ft]). The Gulf opens to the Atlantic Ocean through the Straits of Florida and to the Caribbean Sea through the Yucatan Channel. Approximately 38 percent of the GOM is comprised of shallow and intertidal areas (<20 m [66 ft] deep). The area of the continental shelf ≤200 m (656 ft) deep covers 22 percent, the continental slope (200-3,000 m [656-9,843 ft] deep) covers 20 percent, and the abyssal plain (≥3,000 m [9,843 ft] deep) covers the final 20 percent. The Sigsbee Deep, located in the southwestern quadrant, is the deepest region of the GOM, and reports by different authors state maximum depths that range from 3,750 to 4,384 m (12,303 to 14,383 ft) (Moretzsohn et al., 2011).

The continental shelf has a gentle slope of <1 degree (**Figure A-1**). The continental slope has a slope of 1-2 degrees and extends from the shelf edge to the Sigsbee and Florida Escarpments in water about 3,000 m (9,843 ft) deep. The transition between the continental shelf edge and abyssal depths is a broad to narrow continental slope. Where the Mississippi River has built its delta seaward, the continental shelf is narrow (**Figure A-1**). In the central and western GOM, the continental slope is broad and low-angle, underlain by an extensive canopy of mobilized salt. In contrast, in the eastern GOM, the continental slope is narrow and steep where there is no salt. In the central and western GOM the edge of the salt canopy is recognized as the Sigsbee Escarpment. In the eastern GOM the Florida Escarpment represents the ancient shelf edge during the Cretaceous Period (**Figure A-2**). The topography of the broad slope underlain by salt is irregular and is characterized by canyons, troughs, minibasins, and salt structures with higher relief than surrounding areas. The Sigsbee and Florida abyssal plains (ocean floor) are basically flat plains on which are subtle features having slightly higher topography.

General Geologic Description

The Atlantic and Gulf Coasts of North America are passive continental margins formed during the Triassic-Jurassic break up of the supercontinent called Pangea (**Figure A-2**). As the Gulf was pulled apart, oceanic crust formed in the basin center, and deltas built into the basin along its western and northern margins. Pull apart of the GOM took place along a series of northwest-southeast trending transform faults, interpreted on the basis of deep seismic data, that formed depositional corridors 40-64 km (25-40 mi) wide (Stephens, 2001, p. 137) that profoundly influenced the deposition history of younger sediments (Stephens, 2001, Figures 2, 6, and 7; Stephens, 2009, Figures 1 and 4)).

As the GOM opened, a basin was created that was subjected to repetitive episodes of inundation by marine waters and evaporation of those waters that formed salt deposits beginning in the Middle Jurassic (**Figure A-2**). During the Upper Jurassic, emergent highs (horsts) were exposed and subjected to erosion, while adjacent lows (grabens) filled with overthickened salt and sediment (Stephens, 2009, Figure 2). Repeated flooding and evaporation of the shallow saline waters that filled the basin resulted in a thick, widespread, salt bed (Louann Salt) that was deposited thickest in grabens and thinnest on horsts (Stephens, 2009, Figure 2). Through time, the basin-center oceanic crust cooled, subsided, and was gradually filled with deeper water in which carbonates (limestone, chalk, and reefs) were deposited. The system of transfer faults exhibited varying degrees of relative extensional (pull apart) movement and tectonic subsidence, the results of which are reflected in Tertiary (**Figure A-2**) depositional patterns on top of the basement. Stephens (2010) uses the analogy of a series of piano keys each related to, but independent of, its neighbor as an explanation for how structural corridors responded to the weight of sediment deposited on top of them.

As sediments continued to be deposited atop the Louann Salt in the western and central GOM, the salt became mobilized in response to sedimentary weight beginning in the early Tertiary. A complex suite of salt structures were extruded into overlying sedimentary layers to form simple piercement structures (salt diapirs) along the coast and modern shoreline and, farther out, an extensive salt canopy the terminal edge of which is expressed as the Sigsbee Escarpment (**Figure A-1**). Stephens (2001 and 2009) showed how the architecture of the basement transform fault system has influenced the modern shorelines of the coastal Gulf States and how the modern Mississippi River has been influenced by this basement architecture (Stephens, 2009, p. 746).

Major faults that have been mapped onshore Louisiana (Gagliano et al., 2003; Gagliano, 2005) are extensional faults, referred to as "growth faults," with a sense of movement that is down-to-the-basin that form contemporaneously with the rapid accumulation of large volumes of sediment. Growth faults up sedimentary dip are generally coupled to down dip compressional zones that, on the Mississippi Fan, have formed a complex belt of folds (Peel et al., 1995, Figure 12). Faulting caused by the formation of salt diapirs is the most common type of faulting on the upper slope. Faults can be concordant with growth faulting, called regional faults, or salt withdrawal and diapirism can form faults with an orientation in reverse, or counter-regional faults (Stephens, 2009).

The geology of the GOM has been studied in detail for the identification, exploration, and development of natural gas and oil resources. There are two major sedimentary provinces in the Gulf Coast region: a younger Cenozoic province in the western and central GOM; and an older Mesozoic province in the eastern GOM. The Cenozoic Province is a clastic regime, characterized by thick deposits of sand, silt, and mud of Paleocene to Holocene age (65 million years ago [Mya] to present) (**Figure A-2**) underlain by carbonate rocks (limestone, chalk, reefs) of Jurassic and Cretaceous age (205-65 Mya) (Apps et al., 1994; Salvador, 1991; Galloway et al., 1991). The Mesozoic Province is a largely carbonate (limestone and reef buildups) regime that extends eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida (**Figure A-1**) towards the coastline of Florida.

The Cenozoic Era is commonly divided into two geologic periods—Tertiary and Quaternary (**Figure A-2**). The Tertiary Period (65-1.77 Mya) comprises almost all of the Cenozoic with the shortest period represented by the Quaternary Period (1.77 Mya-Recent) (**Figure A-2**). Over the last 65 million years, the Cenozoic Era, clastic sediments (sands, silts, and clays) from the interior North American continent have entered the GOM basin from the west and north (Apps et al., 1994; Gallaway et al., 1991) to form clastic deltaic systems. During the Cenozoic there were few deltaic systems in the eastern GOM and the terrain drained was largely carbonate rock, resulting in relatively clear water favorable to the formation of carbonate sediments and reef buildups in the marine environment.

Geologists also subdivide the Cenozoic into Epochs of variable duration: from oldest, Paleocene, Eocene, Oligocene, Miocene, Pliocene, Pleistocene, and Holocene (**Figure A-2**). The centers of thick sediment deposition shifted progressively eastward and southward through time in response to changes in the source of sediment supply. In the Paleocene, Eocene, and Oligocene Epochs (65-24 Mya), the Rio Grande River and a system of smaller rivers (Brazos, Colorado, Nueces, etc.) drained the Texas coastal plain and were the main source of sediment supply that built small deltaic systems onto the Texas inner shelf. In the Miocene and Pliocene Epochs (24-1.77 Mya) (**Figure A-2**), the center of sediment deposition shifted eastward as the Mississippi River became the major source of sediments entering the GOM. The modern Mississippi River Delta complex is the present-day reflection of a depositional system that has been building and periodically abandoning successive delta lobes since the Miocene. The course of the river and deltaic lobes built by it were very likely influenced by the basement transform fault-delimited structural corridors identified by Stephens (2001 and 2009). The Mississippi River and Delta deposited a sequence of Tertiary-aged sediments up to 12 km (7.4 mi) thick at the coast that may be as much as 18 km (11.2 mi) thick offshore (Gagliano, 1999). The youngest deltaic lobes built by the Mississippi River over the last 7,000 years of the Holocene Epoch (Frazier, 1967) have been built and abandoned at intervals of about 1,000 years. The subtle topography and geomorphology of the shoreline in the northern GOM are products of ongoing vertical movements along basement transform faults that have operated over the geologic history of the basin (Stephens, 2009, p. 747).

Hydrocarbon System

To produce economically viable accumulations of oil and gas, five physical characteristics must occur in the geologic setting. First, rocks must contain an enriched supply of organic material capable of forming oil and gas through the chemical and physical changes that occur during burial (the source rock). Second, a rock with pores and openings sufficiently connected to hold and transmit oil or gas after it is generated (the reservoir rock). Third, the hydrocarbons must migrate to reservoir rocks from the source.

Fourth, the reservoir rock and the layers above and below it must be structurally and/or stratigraphically configured so as to capture a large accumulation of hydrocarbon resource (the trap). Fifth, the trapping structure (e.g., a fault) or fine-grained rock must overly a reservoir rock or be configured so that the trap prevents the escape of oil or gas (the seal). There is often one more element invoked—timing. That is, these events must be in the proper sequence. For example, a trap may form after oil and gas has migrated through the system to be lost.

Upper Jurassic deposits are considered the major source rocks for gas and oil generation in the GOM. Other source rocks that have been identified in the GOM that may have generated hydrocarbons are as young as Pleistocene-age (approximately 2 Mya) (**Figure A-2**). A geologic "play" is the structural or stratigraphic style of a reservoir rock or trap geometry that is characteristic of a particular geologic age or location on the basin. Different types of hydrocarbon plays occur in each region of the GOM.

Approximately 45,000 wells have been drilled in the GOM. Exploration and development have resulted in the naming of more than 1,270 fields, of which 1,053 were identified, produced, or developed in the GOM (USDOI, MMS, 2006). As of January 1, 2003, the mean undiscovered technically recoverable resources (UTRR) for all plays in the GOM's Outer Continental Shelf (OCS) are estimated to be 86.30 billion barrel of oil equivalent (BBOE).

In the GOM and the Atlantic OCS, hydrates have been studied for two decades by academia, government agencies, and the oil industry. Naturally occurring gas hydrates have been observed and sampled from the Gulf of Mexico OCS in association with oil and gas seeps in localized deepwater areas of very cold temperature and high pressure at or near the seafloor, and in the shallow subsurface. Seep features, including hydrates, result in higher seismic amplitude (higher reflectivity) detected by seismic surveys. Most hydrate occurrences in the GOM are associated with faulting that provides migration pathways for gas to reach the zone where hydrates are stable. The geothermal gradient increases with depth, allowing ideal temperatures only in the upper few thousand feet of sediments for hydrates to be stable.

Mesozoic Plays

Mesozoic plays in the Gulf of Mexico OCS extend eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida towards the coastline of Florida (**Figure A-1**). Although this area has experienced limited drilling and most control points are on the shelf, some general statements can be made concerning resources. This province is dominated by Mesozoic carbonate rocks overlain by some Cenozoic clastic sediment. The hydrocarbon potential has been realized throughout the entire geologic interval from the very shallow, young portion of the Pleistocene (1,500-4,000 ft; 458-1,220 m) to the intermediate Cretaceous James Formation (14,000-16,000 ft; 4,270-4,880 m) and the deep, older Jurassic Norphlet Formation (15,000-24,000 ft; 4,575-7,320 m). Approximately two dozen fields in the Mesozoic Province produce gas from the shallow Cenozoic. In the area offshore of the Florida Panhandle (Pensacola and Destin Dome), a total of 34 wells have been drilled, with 18 of the wells penetrating the Norphlet. The depths at which the Norphlet is found in the Gulf Coast region varies from less than 5,000 ft (1,525 m) onshore to greater than 24,000 ft (7,320 m) subsea offshore Mississippi and 15,000 ft (4,575 m) subsea in the Apalachicola Embayment.

This province has several potential Mesozoic hydrocarbon plays that are downdip equivalents of onshore productive fields. Carbonate rocks often require favorable diagenesis (physical and chemical alterations to the sediments after deposition), faulting, fracturing, and stratigraphy to enhance what is typically the low porosity and permeability. The variability of the porosity and permeability within a carbonate rock increases the risk in the determination of potential drainage area, production rates, and resource volume when hydrocarbons are discovered.

Approximately 350 wells have been drilled in the Mesozoic Province of the Federal offshore, and less is known about the subsurface geology and its natural gas and oil resource potential. To date, the only discovered Mesozoic fields in the OCS are the Jurassic Norphlet (14 fields), the Cretaceous James (9 fields), and the Cretaceous Andrew (1 field). Most of these fields are located in the northeastern portion of the Central Planning Area (CPA). The BOEM has identified 24 plays in the Mesozoic Province: 3 proven and 21 conceptual.

Cenozoic Plays

Plays of the Cenozoic Province extend from offshore Texas eastward across the north-central GOM to the edge of the Cretaceous Shelf Edge (commonly known as the Florida Escarpment) offshore Mississippi, Alabama, and Florida (**Figure A-1**). It incorporates all of the Western Planning Area (WPA), a large portion of the CPA, and the southwestern portion of the Eastern Planning Area (EPA). To date, hydrocarbon production on the OCS in the Cenozoic Province is from reservoir sands ranging in age from Oligocene to Pleistocene (approximately 34-0.2 Mya) (**Figure A-2**).

The hydrocarbon plays in the western and central GOM are typically influenced by salt piercement structures. Because salt is less dense than sand, silt, or clay, it tends to become mobilized as denser sediments are deposited over it. The loading of sediment on the continental shelf in the early Tertiary and and the upward movement of salt during the later Tertiary has formed a vast canopy of mobilized salt that has essentially been extruded up and now lie over most of the OCS and slope sediments. The requirements for a good hydrocarbon province are met in the western and central GOM. First, the movement of salt upward pierces overlying sedimentary layers to form structures capable of trapping oil and gas. Piercement structures create pathways for migration of hydrocarbon from Upper Jurassic, Lower Cretaceous, and/or Lower Tertiary source beds to younger reservoir sands. Second, thick sands deposited by deltas or deep-sea fans have been deposited with good porosity (pore space between the sand grains where oil and gas can accumulate) and permeability (connections between the pore spaces through which oil and gas can flow) are good reservoir rocks. Third, impermeable shales, salt, and/or faults serve as seals for trapping oil and gas in reservoir rock pore spaces.

One prolific Cenozoic play is the Mississippi fan fold belt (Peel et al., 1995, Figure 12). The fold belt is formed by down dip compression caused by sediment loading from the Mississippi Delta up sedimentary dip. In the Mississippi Canyon and Atwater protraction areas lie some of the largest fields in the GOM that are part of this play, among them Thunder Horse, the largest single reservoir yet found in the GOM.

The age of rock from where most hydrocarbon production occurs on the continental shelf and slope are mainly Miocene, Pliocene, and Pleistocene. The BOEM has assessed 28 plays in the Cenozoic Province: 27 proven and 1 conceptual play. The Cenozoic productive intervals become thinner with less hydrocarbon potential eastward in the direction of the Cretaceous shelf edge (Mesozoic Province) (**Figure A-2**). The Mesozoic section has been penetrated by wells in the overlap area of the Cenozoic/ Mesozoic Provinces, with commercial hydrocarbons being identified in several fields.

Deep Gas (Continental Shelf)

The clastic sediments (sands and shales) of the GOM were deposited mostly in deltaic depositional systems that are influenced by the location of the sediment source, morphology of the seabed, and the edge of the shelf. Usually the most abundant reservoir rocks are deposited as channel or delta front sands on the shelf. Shifting of the delta complex and ocean currents tend to widely disperse these sands laterally along the shelf. On the shelf, in shallower water, early GOM exploration targeted these sands as potential hydrocarbon traps. In deeper water on the continental slope and abyssal plains, the sands were deposited by turbidite fans are finer-grained and gradually become thinner and less depositionally continuous farther from the continental shelf margin.

The present-day shelf was once the slope environment during the Oligocene and Miocene age (approximately 34-5.3 Mya) (**Figure A-2**) when sea level was higher. The shelf area holds the potential for deepwater delta systems with channels, distributary bars, levees, overbank deposits, and large fan lobes that have been buried, sometimes deeply, by younger Pliocene and Pleistocene depositional systems. Subsequent faulting and salt movement created traps and supplied conduits for the migration of hydrocarbons. Pore pressure increases with depth because of the overburden of the sediments and the amount of water trapped within the sediments. Temperature also increases with depth and can be even higher in areas with less salt intrusions into the sediments. The presence of salt has a cooling effect on the surrounding sediments, causing areas with salt intrusions to have lower temperatures. It is anticipated that these older, deeper reservoirs will be more likely located adjacent to or under the present shelf fields. Deeply buried reservoirs would be subjected to high pressures (HP) and high temperatures (HT). The so-called HPHT environment is one challenging the limits for drilling and strength tolerances of steel.

The shelf off the western and central Louisiana coast is also prospective for the older and deeper Mesozoic age reservoir rocks. These rocks would also be under HPHT conditions because of their depth. The Mesozoic environment of deposition on the shelf is projected to be shallow-water carbonates and reefs.

Deep Water (Continental Slope and Abyssal Plain)

The continental slope in the GOM extends from the shelf edge to approximately 2,000 m (6,562 ft) water depth. The seafloor gradient on the slope varies from 3 to 6 degrees to in excess of 20 degrees in places along the escarpments. At the base of the Cenozoic Province slope is an apron of thick sediment accumulation referred to as the continental rise, inclining seaward from the Sigsbee Escarpment in transition to the abyssal plain.

Bathymetric maps of the continental slope in the northwestern GOM (Bryant et al., 1990; Bouma and Bryant, 1994) reveal the presence of over 105 intraslope basins with relief in excess of 150 m (492 ft), 28 mounds, and 5 major and 3 minor submarine canyons. These intraslope basins occupy much of the area of the continental slope. Hydrocarbon traps adjacent to minibasins and below the salt canopy are common plays on the continental slope.

The middle and lower portions of the Cenozoic Province continental slope contain a canopy of salt, which has moved down-slope in response to sediment loading on the shelf and upper slope. The Sigsbee Escarpment is the southern edge of the canopy within the GOM. Prominent submarine canyons occur along the lower continental slope and rise and the Sigsbee Escarpment (Alaminos, Keathley, Bryant, Cortez, Farnella, and Green Canyons), each evolving from, in part, the coalescing and migration of salt canopies, an unusual process for the formation of submarine canyons (Bouma and Bryant, 1994; Bryant et al., 1990; Bryant et al., 1991). Buried turbidite fans from the slope and rise spilling onto the abyssal plain have been play types in ultra-deepwater (≥5,000 ft; 1,525 m). Submarine fans of various sizes extend seaward of the edge of the Sigsbee Escarpment onto the continental rise. Although slopes in excess of 15 degrees are found, the majority of the slopes along the canyon walls and the escarpment range from 5 to 10 degrees.

Geologic Hazards

The Mississippi River Delta presents a unique set of geologic hazards because of high sedimentation rates that resulted in sediments with high-water-content and low-strength. Under these conditions, the sediments can be unstable, and slope failure or mass transport of sediments can result. These failures can be triggered by cyclic leading associated with hurricanes, overloading or oversteepening of the slope sediments, or uplift associated with movement of salt. These failures can form mudflow gullies, overlapping mudflow lobes, collapse depressions, slumps, and slides. Small, buried, river channels can result in differential sediment compaction and pose a hazard to jackup rigs.

Over-pressure conditions in a sedimentary section can result from loading by rapid deposition, sand collapse, in-leaking gas, or salt tectonics. Drilling through an over-pressured, shallow-gas pocket can cause loss of mud circulation or a blowout (a blowout occurs when improperly balanced well pressure results in sudden uncontrolled release of fluids from a wellbore or wellhead). A shallow-water flow can cause similar drilling problems. Over-pressured conditions can develop in deep water when “water sand” is trapped by a shale seal. Over-pressured formation water may escape around or through the wellbore to the seafloor and wash out the well foundation. No shallow-water flow event in the GOM has resulted in an oil spill. Over-pressured conditions may be found while penetrating naturally occurring gas hydrates below which lies free gas that can cause a loss of well control incident.

Deep drilling may encounter abnormally high geopressures. Deep drilling may also encounter hydrogen sulfide, which can occur near salt domes overlain by caprock and is the product of sulfate reducing microbes.

Potential Mitigation Measures

The best mitigation for most hazards is avoidance after detection by a geophysical survey. Leaseholders are required to run geophysical surveys before drilling in order to locate potential geologic or manmade hazards (30 CFR 250.214). In deep water, most companies do a remotely operated vehicle (ROV) inspection of the seafloor before drilling begins. Companies are also required to take and analyze sediment borings for platform sites. Areas of hydrogen sulfide occurrences can be predicted and sensors installed on drilling rigs to warn operators. Certain leases also require archaeological surveys and live-bottom surveys to protect sensitive areas. Every application for permit to drill a well in the GOM is reviewed by BOEM geologists, geophysicists, and engineers to ensure compliance with standard drilling practices and BOEM regulations. All rigs and platforms are inspected by the Bureau of Safety Environmental Enforcement on a regular basis to ensure all equipment and procedures comply with Federal regulations for safety and environmental protection.

Geologic Condition	Hazard	Mitigations
Fault	Bend/shear casing Lost circulation Gas conduit	Stronger casing/heavier cement
Shallow Gas	Lost circulation Blowout Crater	Kill mud Pilot hole Circulate mud/drill slower Blow-out preventer/diverter Pressure while drilling log
Buried Channel	Jack-up leg punch through	Pre-load rig Mat support All rig legs in same type of sediment
Slump	Bend/shear casing	Thicker casing Coil/flexible pipeline
Water Flow	Erosion/washout Lost circulation	Kill mud, foam cement Pilot hole Pressure while drilling

A.2. Physical Oceanography

Introduction

The Gulf of Mexico is a semienclosed, subtropical sea with an area of approximately 1.5 million square kilometers (km^2) (371 million acres). The main physiographic regions of the Gulf Basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, abyssal plains, the Yucatan Channel, and Florida Straits. The continental shelf width along the U.S. coastline is about 10 miles (mi) (16 km) off the Mississippi River, and 97 mi (156 km) off Galveston, Texas, decreasing to 55 mi (88 km) off Port Isabel near the Mexican border. The depth of the central abyss ranges to approximately 3,700 m (12,139 ft). The water volume of the entire Gulf, assuming a mean water depth of 1 mi (2 km), is 2 million km^3. The water volume of the continental shelf, assuming a mean water depth of 50 m (164 ft), is 25,000 km^3.

The origins of the principal watermasses in the GOM have been identified and include subtropical underwater, Sargasso Sea water, Tropical Atlantic Central Water, Antarctic Intermediate Water, and a deepwater mixture of watermasses **(Table A-1)**. This table excludes the highly variable surface waters observed in the eastern and western GOM (e.g., Nowlin and McLellan, 1967). Watermass property extremes are closely associated with specific density surfaces. All of these subsurface waters derive from outside the Gulf and enter from the Caribbean Sea through the Yucatan Channel. Below about 1,800 m (5,906 ft), horizontal distributions of temperature and salinity within the Gulf are essentially uniform (Nowlin, 1972).

Shelf Circulation

Shelf water temperature and salinity varies seasonally based on changes in river inflow, surface solar heating, winds and related mixing, and downwelling and upwelling processes. Summer heating and stratification affect continental-shelf waters in the GOM and are factors contributing to summertime hypoxia on the Louisiana-Texas shelf. Salinity is generally lower nearshore due to freshwater inputs from the Mississippi and other rivers. However, these fresh waters occasionally move into outer shelf waters and even out over deep waters of the Gulf, as when entrained by the Loop Current (Weisberg et al., 2005). Cold water from deeper off-shelf regions moves onto and off of the continental shelf by cross-shelf flow associated with upwelling and downwelling processes.

Continental shelf waves may propagate along the continental slopes of the GOM. These are long waves similar to topographic Rossby Waves (TRW's), but their energy is concentrated along a sloping bottom with shallow water to the right of the direction of propagation and, because of this constraint, they are effectively "trapped" by the sloping bottom topography (Hamilton, 1990).

A class of energetic surface currents was found over the Texas and Louisiana shelves during the Agency-sponsored Texas-Louisiana Shelf Circulation and Transport Process (LATEX) program of the early 1990's (Nowlin et al., 1998). July 1992 observations in 200-m (656-ft) water depth offshore of Louisiana were of maximum amplitudes of 40-60 cm/s (16-27 in/s) at a depth of 12 m (39 ft) during conditions of light winds. The period of diminished amplitudes followed an atmospheric frontal passage. These are near-circular, clockwise-rotating oscillations with a period near 24 hours. They seem to be an illustration of thermally induced cycling (DiMarco et al., 2000) in which high-amplitude rotary currents can exist in thin mixed layers typical of summer. Many examples of such currents, in phase at distinct locations, exist for the Texas-Louisiana shelf and, by implication, farther offshore. Currents at a depth of 1 m (3 ft) have been observed to reach 100 cm/s (40 in/s).

Inner-shelf currents on the Louisiana-Texas continental shelf flow in the downcoast (south or west) direction during nonsummer months, reversing to upcoast flow in the summer (Cochrane and Kelly, 1986; Nowlin et al., 2005). Modeling results show that the spring and fall reversals in alongshore flow can be accounted for by local wind stress alone (Current, 1996). Monthly averaged alongshore currents on the outer shelf are upcoast in the mean, but they showed no coherent pattern in the annual signal and were not often in the same alongshore direction at different outer-shelf locations (Nowlin et al., 1998). Mean cross-shelf geostrophic transport observed at the Louisiana-Texas shelf break was offshore during the winter (particularly in the upper 70 m (230 ft) of the water column), and onshore during the summer (Current and Wiseman, 2000).

Circulation on the continental shelf in the northeastern GOM has been observed to follow a cyclonic pattern, with westward alongshore currents prevailing on the inner and middle shelf and opposing alongshore flow over the outer shelf and slope (Brooks, 1991). Inner shelf currents are primarily wind driven and are also influenced by river outflow and buoyancy forcing from water discharged by the Mississippi, Apalachicola, Tombigbee, Alabama, and other rivers in the region. Cold water from deeper off-shelf regions moves onto and off of the continental shelf by cross-shelf flow associated with upwelling and downwelling processes. Upwelling of nutrient rich, cold water onto the shelf in 1998 was correlated with hypoxia, anoxia, and mass mortalities of fishes and invertebrates in the region, although causation has not been established (Collard and Lugo-Fernandez, 1999).

Mean circulation on the West Florida inner shelf tends to be along the coast towards the southeast during the winter, and it reverses to be along coast towards the northwest during the summer. These seasonal means in flow direction are because of the influence of seasonal local winds and heat flux forcing. Midshelf flow (around the 50-m [164-ft] isobath) can be in the opposite direction from inner shelf flow on the broad, gently sloping West Florida shelf because of the partial closure imposed by the Florida Keys to the south. The outer shelf is an area of transition between deepwater currents over the continental slope and the shelf regime. The nearshore regions are influenced by freshwater outflow from rivers and estuaries. Mississippi River water is advected onto the West Florida shelf at times in spring and summer because of strong currents along the shelf break. Fresh water from the Mississippi River is sometimes entrained by the Loop Current as well (Weisberg et al., 2005).

Loop Current and Eddies

The Loop Current, the dominant circulation feature in the Gulf, enters through the Yucatan Channel and exits through the Florida Straits. The sill depth at the Florida Straits is about 700 m (2,300 ft); the effective sill depth at the Yucatan Channel is nearly 2,000 m (6,560 ft) (Badan et al., 2005). Watermasses in the Atlantic Ocean and Caribbean Sea that occur at greater depths cannot enter the GOM. The Loop Current is a part of the western boundary current system of the North Atlantic. This is the principal current and source of energy for the circulation in the Gulf. The Loop Current has a mean area of 142,000 km^2 (35 million ac) (Hamilton et al., 2000). It may be confined to the southeastern GOM or it may extend well into the northeastern or north-central Gulf (**Figure A-3**), with intrusions of Loop Current water northward and on to the West Florida Shelf (Vukovich, 2005).

Closed rings of clockwise-rotating (anticyclonic) water, called Loop Current Eddies (LCE's) separate from the Loop Current at intervals of 5 to 19 months (Vukovich, 2005). These LCE's are also called warm-core eddies, since they surround a central core of warm Loop Current water. The LCE's have diameters of 200-400 km (124-248 mi), rotate with periods of 8-15 days, and travel on average at 4.4 km/day ± 2.9 km/day (2.7 mi/day ± 2.8 km/day) into the western Gulf (Vukovich, 2007). The Loop Current usually penetrates about as far north as 27°N. latitude just prior to shedding an LCE (Vukovich, 2005). A recent study of satellite-derived Loop Current metrics demonstrated a linear correlation between the retreat latitude of the Loop Current following eddy separation and the subsequent eddy separation period (Lugo-Fernández and Leben, 2010). This study provided a recommended forecasting tool for Loop Current eddy separation in the Gulf of Mexico. Currents associated with the Loop Current and its eddies extend to at least depths of 700 m (2,300 ft), the sill depth of the Florida Straits, and geostrophic shear is observed to extend to the sill depth of the Yucatan Channel. Warm-core eddies can have life spans of 1 year or more (Elliot, 1982). Therefore, their effects can persist at one location for long periods—weeks or even months (e.g., Nowlin et al., 1998). Energetic, high-frequency currents have been observed when LCE's flow past structures, but they are not well documented. Such currents would be of concern to offshore operators because they could induce structural fatigue of materials. Loop Current eddies decay and generate secondary cyclones and anticyclones (Science Applications International Corporation, 1988) by interactions with boundaries, ring shedding, and ring-ring interactions. The net result is that, at almost any given time, the Gulf is populated with numerous eddies, which are interacting with one another and with the margins (Science Applications International Corporation, 1988; Hamilton and Lee, 2005).

Cold-core cyclonic (counter-clockwise rotating) eddies have been observed in the study region as well. These cyclones are often called cold-core eddies, since they surround a central core of seawater that is cooler and fresher than adjacent waters. Cyclonic circulation is associated with upwelling, which brings cooler, deeper water towards the surface. Frontal or cold cyclonic waves form along the edge of the Loop Current, and similar cold cyclones have also been observed on the periphery of LCE's (Vukovich, 2007). Statistics of cold cyclones include spatial scales of 30-150 km (19-93 mi) in diameter and speeds of 4-26 km/day (~2-16 mi/day) (e.g., Walker et al., 2009). Small cyclonic eddies around 50-100 km (31-62 mi) in diameter have been observed over the continental slope off Louisiana (Hamilton, 1992). These eddies can persist for 6 months or longer and are relatively stationary.

Near the bottom of the Loop Current, velocities are low and fairly uniform in the vertical although with bottom intensification, a characteristic of topographic Rossby Waves (TRW's). This indicates that the Loop Current is in fact a source of the TRW's, which are a major component of deep circulation below 1,000 m (3,281 ft) in this part of the Gulf (Sturges et al., 1993; Science Applications International Corporation, 1989; Hamilton, 1990). Exchange of surface and deep water occurs with descent of surface water beneath the Loop Current in the eastern GOM and with the ascent of deep water in the northwestern GOM where LCE's spin down (Welsh and Inoue, 2002). The Sturges et al. (1993) model suggests a surprisingly complex circulation pattern beneath LCE's, with vortex-like and wave-like features that interact with the bottom topography (Welsh and Inoue, 2000). These model findings are consistent with Hamilton's (1990) interpretation of observations.

The major large-scale, permanent circulation feature present in the WPA and CPA is an anticyclonic (clockwise-rotating) feature oriented about east-northeast, west-southwest with its western extent near 24° N. latitude off Mexico. There has been debate regarding the mechanism for this anticyclonic circulation and the possible associated western boundary current along the coast of Mexico. Elliott (1982) attributed LCE's as the primary source of energy for the feature, but Sturges (1993) argued that wind stress curl over the western Gulf is adequate to drive an anticyclonic circulation with a western boundary current. Sturges (1993) found annual variability in the wind stress curl corresponding to the strongest observed boundary current in July and the weakest in October. Based on ship-drift data, Sturges (1993) showed the maximum northward surface speeds in the western boundary current were 25-30 cm/s (10-12 in/s) in July and about 5 cm/s (2 in/s) in October; the northward transport was estimated to vary from 2.5 to 7.5 m^3/s (8.2 to 24.6 ft/s). He reasoned that the contribution of LCE's to driving this anticyclonic feature must be relatively small. Others have attributed the presence of a northward flow along the western Gulf boundary to ring-slope-ring interactions (Vidal et al., 1999).

Deepwater Currents

Mean deep (~2,000 m; ~6,562 ft) flow around the edges of the GOM circulates in a cyclonic (counterclockwise) direction (Sturges et al., 2004). A net counterclockwise circulation pattern was also observed at about 900-m (2,953 ft) water depth around the borders of the GOM (Weatherly, 2004).

Occasionally, currents have been directly measured at abyssal depths exceeding 3,000 m (9,843 ft) in the GOM. The major low-frequency fluctuations in velocity of these currents in the bottom 1,000-2,000 m (3,281-6,562 ft) of the water column have the characteristics of TRW's. These long waves have wavelengths of 150-250 km (93-155 mi), periods greater than 10 days, and group velocities estimated at 9 km/day (~6 mi/day). They are characterized by columnar motions that are intensified near the seafloor. They move westward at higher group velocities than the translation velocity of 3-6 km/day (2-4 mi/day) that is typical of anticyclonic eddies. The Loop Current and LCE's are thought to be major sources of these westward propagating TRW's (Hamilton, 1990; Oey et al., 2004). These TRW's transition from short to longer period in going from east to west over the GOM basin, probably because of bottom slope and regional bathymetric conditions (Donohue et al., 2006).

In general, past observations of currents in the deepwater GOM have revealed decreases in current speed with depth. During late 1999, a limited number of high-speed current events, at times approaching 100 cm/s (39 in/s), were observed at depths exceeding 1,500 m (4,921 m) in the northern GOM (Hamilton and Lugo-Fernandez, 2001; Hamilton et al., 2003). Furrows oriented nearly along depth contours were observed in the region of 90^{o} W. longitude just off the Sigsbee Escarpment and near the Bryant Fan, south of Bryant Canyon, from 91^{o} to 92.5^{o} W. longitude. Depths in those regions range from 2,000 to 3,000 m (6,562 to 9,843 ft). Speculation based partly on laboratory experimentation is that near-bottom speeds of currents responsible for the furrows that are closest to shore might be 50 cm/s (20 in/s), and possibly in excess of 100 cm/s (39 in/s), and these currents may be oriented along isobaths and increase in strength toward the escarpment. These currents might be sporadic or quasi-permanent.

In deep water, several oil and gas operators have observed very high-speed currents in the upper portions of the water column. These high-speed currents can last as long as a day. Such currents may have vertical extents of less than 100 m (328 ft), and they generally occur within the depth range of 100-300 m (328-984 ft) in total water depths of 700 m (2,297 ft) or less over the upper continental slope. Maximum speeds exceeding 150 cm/s (59 in/s) have been reported. The mechanisms by which these currents are generated may include motions derived from the Loop Current and associated eddies, motions due to eddy-eddy and/or slope-shelf/eddy interaction, internal/inertial wave motions, instabilities along eddy frontal boundaries, and biases in the data record related to instrument limitations (DiMarco et al., 2004).

Storm Events

Tropical conditions normally prevail over the Gulf from May or June until October or November. Hurricanes increase surface current speeds to 100-150 cm/s (40-59 in/s) over the continental shelves and cool the surface waters in much the same way as do cold fronts, but they may stir the mixed layer to an even greater depth. Wind events such as tropical cyclones (especially hurricanes), extra tropical cyclones, and cold-air outbreaks can result in extreme waves and cause currents with speeds of 100-150 cm/s (40-59 in/s) over the continental shelves. Examples for the Texas-Louisiana shelf and upper slope are given in Nowlin et al. (1998) and for the Alabama shelf during Hurricane Ivan in Mitchell et al. (2005). Other researchers (e.g., Brooks, 1983 and 1984) have measured the effects of such phenomena down to depths of 700 m (2,297 ft) over the continental slope in the northwestern Gulf. Hurricanes can trigger a series of internal waves with near inertial period. Surface waves and sea state may limit normal oil and gas operations as well as oil-spill-response activities (French et al., 2005; Fingas, 2001). Waves as high as 91 ft (28 m) were measured under Hurricane Ivan (Wang et al., 2005). Recently, a new mode was found to transport hurricane energy downward related to the sea-level rise near the storm eye (Welsh et al., 2009; Cole and DiMarco, 2010).

Cold fronts, as well as diurnal and seasonal cycles of heat flux at the air/sea interface, affect near-surface water temperatures, although water at depths greater than about 100 m (328 ft) remains unaffected by surface boundary heat flux. Water temperature is greater than air temperature at the air/sea interface during all seasons. Frontal passages over the region can cause changes in temperature and velocity structure in the upper layers, specifically increasing current speeds and variability. These fronts tend to occur with frequencies from 3 to 10 days (weatherband frequency). In the winter, the shelf water is nearly homogeneous due to wind stirring and cooling by fronts and winter storms.

A.3. METEOROLOGICAL CONDITIONS

The GOM is influenced by a maritime subtropical climate controlled mainly by the clockwise circulation around the semipermanent area of high barometric pressure commonly known as the Bermuda High. The GOM is located to the southwest of this center of circulation. This proximity to the high-pressure system results in a predominantly southeasterly flow in the GOM region. Two important classes of cyclonic storms are occasionally superimposed on this circulation pattern. During the winter months, December through March, cold fronts associated with cold continental air masses influence mainly the northern coastal areas of the GOM. Behind the fronts, strong north winds bring drier air into the region. Tropical cyclones may develop or migrate into the GOM during the warmer months. These storms may affect any area of the GOM and substantially alter the local wind circulation around them. In coastal areas, the sea breeze effect may become the primary circulation feature during the summer months of May through October. In general, however, the subtropical maritime climate is the dominant feature in driving all aspects of the weather in this region; as a result, the climate shows very little diurnal or seasonal variation.

Selected climatological data for a few selected Gulf coastal locations can be found in **Table A-2**. The western extension of the Bermuda High dominates the circulation throughout the year, weakening in the winter and strengthening in the summer. The average monthly pressure shows a west to east gradient along the northern Gulf during the summer. In the winter, the monthly pressure is more uniform along the northern Gulf. The minimum average monthly pressure occurs during the summer. The maximum pressure occurs during the winter as a result of the presence and influence of transitional continental cold air.

Average air temperatures at coastal locations vary with latitude and exposure. Air temperature ranges from highs in the summer of 24.7-28.0 ^{o}C (76.5-82.4 ^{o}F) to lows in the winter of 2.1-21.7 ^{o}C (35.8-71.1 ^{o}F). Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperatures over the open Gulf exhibit narrower limits of variations on a daily and seasonal basis due to the moderating effect of the large bodies of water. The average temperature over the center of the Gulf is about 29 ^{o}C (84 ^{o}F) in the summer and between 17 and 23 ^{o}C (63 and 73 ^{o}F) in the winter.

The relative humidity over the Gulf is high throughout the year. Minimum humidities occur during the late fall and winter when cold, continental air masses bring dry air into the northern Gulf. Maximum humidities occur during the spring and summer when prevailing southerly winds bring in warm, moist air. The climate in the southwestern GOM is relative dry.

Winds are more variable near the coast than over open waters because coastal winds are more directly influenced by the moving cyclonic storms that are characteristic of the continent and because of the land and sea breeze regime. During the relatively constant summer conditions, the southerly position of the Bermuda High generates predominantly southeasterly winds, which become more southerly in the northern Gulf. Winter winds usually blow from easterly directions with fewer southerlies but more northerlies.

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. Stations along the entire coast record the highest precipitation values during the warmer months of the year. The warmer months usually have convective cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have attendant hail (USDOC, 1967; Brower et al., 1972). The month of maximum rainfall for most locations is July. Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady, and relatively continuous, often lasting several days. Snowfalls are rare, and when frozen precipitation does occur, it usually melts on contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero.

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. Fog occurrence decreases seaward, but visibility has been less than 800 m (2,625 ft) due to offshore fog. Coastal fogs generally last 3-4 hours, although particularly dense sea fogs may persist for several days. The poorest visibility conditions occur during winter and early spring. The period from

November through April has the lowest visibility. Industrial pollution and agricultural burning also impact visibilities.

The mixing height is very important because it determines the volume available for dispersing pollutants. Because the mixing height is directly related to vertical mixing in the atmosphere, a mixed layer is expected to occur under neutral and unstable atmospheric conditions. The mixing height tends to be lower in winter, and daily changes are smaller than in summer.

The GOM is part of the Atlantic tropical cyclone basin. Tropical cyclones generally occur in summer and fall seasons; however, the Gulf also experiences winter storms or extratropical storms. These winter storms generally originate in middle and high latitudes and have winds that can attain speeds of 15-26 m/sec (11.2-58.2 mph). The Gulf is an area of cyclone development during cooler months due to the contrast of the warm air over the Gulf and the cold continental air over North America. Cyclogenesis, or the formation of extratropical cyclones, in the GOM is associated with frontal overrunning (Hsu, 1992). The most severe extratropical storms in the Gulf originate when a cold front encounters the subtropical jetstream over the warm waters of the Gulf. Statistics of 100-year data of extratropical cyclones reveal that most activity occurs above 25° N. latitude in the western GOM. The mean number of these storms ranges from 0.9 near the southern tip of Florida to 4.2 over central Louisiana (Ford et al., 1988).

The frequency of cold fronts in the Gulf exhibits similar patterns during the 4-month period of December through March. During this time the area of frontal influence reaches 10° N. latitude. Frontal frequency is about nine fronts per month (1 front every 3 days on the average) in February and about seven fronts per month in March (1 front every 4-5 days on the average). By May, the frequency decreases to about four fronts per month (1 front every 7-8 days) and the region of frontal influence retreats to about 15° N. latitude. During June-August frontal activity decreases to almost zero and fronts seldom reach below 25° N. latitude (Ford et al., 1988).

Tropical cyclones affecting the Gulf originate over the equatorial portions of the Atlantic Ocean, the Caribbean Sea, and the GOM. Tropical cyclones occur most frequently between June and November. Based on 50 years of data, there are about 9.6 storms per year with about 5.9 of those becoming hurricanes in the Atlantic Ocean. Data from 1950 to 2000 show that 79 percent of these storms, or 4.7 storms per year, will affect the GOM (Klotzbach and Gray, 2005). The Yucatan Channel is the main entrance of Atlantic storms into the GOM, and a reduced translation speed over Gulf waters leads to longer residence times in this basin.

There is a high probability that tropical storms will cause damage to physical, economic, biological, and social systems in the Gulf. Tropical storms also affect OCS operations and activities; platform design needs to consider the storm surge, waves, and currents generated by tropical storms. Most of the damage is caused by storm surge, waves, and high winds. Storm surge depends on local factors, such as bottom topography and coastline configuration, and storm intensity. Water depth and storm intensity control wave height during hurricane conditions. Sustained winds for major hurricanes (Saffir-Simpson Category 3 and above) are higher than 49 m/sec (109.6 mph). During the past few years the Gulf Coast States have been impacted by several major hurricanes—Hurricanes Lili (2002), Ivan (2004), Katrina (2005), Rita (2005), Gustav (2008), and Ike (2008).

A.4. ARTIFICIAL REEFS AND RIGS-TO-REEFS DEVELOPMENT

Artificial reefs have been used along the coastline of the U.S. since the early nineteenth century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish, but in some instances also enhance the production of fish.

The long-standing debate as to whether artificial reefs contribute to biological production or merely attract the associated marine resources still continues within the scientific arena. The generally accepted conclusion is that artificial reefs both attract and produce fish. This conclusion depends on a variety of factors, such as associated species, limiting environmental factors, fishing pressure, and type of materials used. The degree to which any of the above factors can be controlled will dictate whether any particular artificial reef attract fish or produce fish. In reality, many artificial reefs probably do both attract and produce fish at the same time.

The U.S. Congress passed the National Fishing Enhancement Act (NFEA) in 1984. The NFEA called for the development of a national plan to provide guidance to those individuals, organizations, and agencies interested in artificial reef development and management. The NFEA directed the Secretary of

Commerce to develop and publish a long-term National Artificial Reef Plan (NARP) to promote and facilitate responsible and effective use of artificial reefs using the best scientific information available. In 1985, the NOAA's National Marine Fisheries Service (NOAA Fisheries Service) wrote and completed the NARP. The NARP states that properly designed, constructed, and located artificial reefs can enhance the habitat and diversity of fishery resources; enhance U.S. recreational and commercial fishing opportunities; increase the energy efficiency of recreational and commercial fisheries; and contribute to the U.S. coastal economies.

The NARP provides general criteria for selection of materials for artificial reefs. These criteria include the following: (1) function, which is related to how well a material functions as reef habitat; (2) compatibility, which is related to how compatible a material is with the environment; (3) durability, which is related to how long a material will last in the environment; (4) stability, which is related to how stable a material will be when subject to storms, tides, currents, and other external forces; and (5) availability, which is related to how available a material is to an artificial reef program.

One of the most significant recommendations in the NARP was to encourage the development of State-specific artificial reef plans. The Gulf States Marine Fisheries Commission (GSMFC) and Atlantic States Marine Fisheries Commission (ASMFC) began to coordinate State artificial reef program activities for States along the coast of the GOM and Atlantic Ocean, respectively. Most of the States along the Gulf and Atlantic Coasts have taken a leadership role in artificial reef development and management, having developed state-specific plans, and established protocols for siting, deployment, and evaluation of materials for artificial reefs. Each commission formed working committees comprised of State artificial reef program personnel, and representatives from appropriate Federal agencies, including the BOEM. Artificial Reef Working Committees of the GSMFC and ASMFC meet jointly to discuss artificial reef issues of a national scope, and separately to discuss issues specific to the Gulf and Atlantic regions. As a result, these committees have been influential in shaping regional and national artificial reef policies and effecting future positive program changes within State and Federal agencies. The working committees have developed guidelines for marine artificial reef materials. The guidelines provide State and Federal agencies and the general public information related to the history, identification of the benefits, drawbacks, and limitations, and use of selected materials for use in the development of marine artificial reefs. The working committees have also produced the document titled *Coastal Artificial Reef Planning Guide*. The document reflects the working committee's recommendations to NOAA Fisheries Service for revisions to the National Artificial Reef Plan.

State Artificial Reef Programs

All of the five Gulf Coast States—Texas, Louisiana, Mississippi, Alabama, and Florida—have artificial reef programs and plans. The following are brief descriptions of each State's artificial reef program. The States' artificial reef planning areas, general permit areas, and permitted artificial reef sites within the area of influence considered in this EIS are shown in **Figure A-4**.

Texas

In 1989, the Texas State legislature passed the State's Artificial Reef Act. The Act provided guidance for planning and developing artificial reefs in a cost-effective manner to minimize conflicts and risk to the environment. The Act also directed the Texas Parks and Wildlife Department to promote, develop, maintain, monitor, and enhance the artificial reef potential in State waters and Federal waters adjacent to Texas. The Act defined an artificial reef as a structure constructed, placed, or permitted in the navigable water of Texas or water of the Federal exclusive economic zone adjacent to Texas for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities. To fulfill these purposes, the Department was directed to develop a State artificial reef plan in accordance with Chapter 89 of the Texas Parks and Wildlife code. Texas artificial reefs are mostly retired oil and gas platforms, liberty ships, and military hardware (battle tanks and armored vehicles).

Louisiana

In response to the NFEA, the Louisiana Artificial Reef Initiative (LARI) combined the talents of university, State, Federal, and industry representatives to develop an artificial reef program for the State of Louisiana. As a result, the Louisiana Fishing Enhancement Act (Act 100) became law in 1986.

Subsequently, the Louisiana Artificial Reef Plan was written and contains the rationale and guidelines for implementation and maintenance of the State artificial reef program. The State plan is implemented under the leadership of the Louisiana Department of Wildlife and Fisheries.

The LARI approved nine artificial reef planning areas where artificial reefs can be sited (Kasprzak and Perret, 1996). Artificial reef complexes are established within the planning areas on the basis of the best available information regarding bottom type, currents, bathymetry, and other factors affecting performance and productivity of the reefs. Retired oil and gas platforms are the primary materials that have been use within the Louisiana artificial reef program. Military battle tanks have also been deployed offshore Louisiana for artificial reefs.

Mississippi

Mississippi's artificial reef efforts began in the 1960's. A group consisting primarily of charter boat operators and recreational fishermen obtained funding from their local coastal counties and constructed a car body reef site in the early 1960's. In 1972, the Mississippi Marine Conservation Commission, the organizational predecessor of the current Mississippi Department of Marine Resources, acquired five surplus liberty ships for artificial reefs. This liberty ship project was completed in 1978. The excess funds from the project and the reef permits were transferred to the Mississippi Gulf Fishing Banks, Inc., a private reef building organization made up of conservationists, charter boat operators, and recreational fishermen.

Presently, Mississippi has 47 nearshore, low-profile fishing reefs and 12 offshore reefs. Most of the offshore sites are located within 16-23 km (10-14 mi) from shore. Artificial reef materials used on these sites include liberty ships, rig quarters, tugboats, barges, boxcars, buses, dumpsters, concrete modules, tires, and oil and gas platforms. All of Mississippi's reef sites have active reef permits and suitable material can be deployed at these sites, as they become available (Brainard, 1996).

Alabama

Alabama's artificial reef efforts began in 1953. The first reef project resulted in placement of 250 automobile bodies in water depths of 20-30 m (66-98 ft) offshore Baldwin County. Alabama Department of Conservation and Natural Resources (ADCNR) is the responsible State agency for artificial reef development in State and Federal waters. Alabama's most impressive and lasting contribution to artificial reef activities is the acquisition and placement of five liberty ships in five locations in Alabama's offshore waters, which provide excellent offshore fishing opportunities for recreational fisherman. In 1986 and 1987, the ADCNR was granted by the U.S. Army Corps of Engineers (COE) two artificial reef, general permit areas (Don Kelly North and Don Kelly South) offshore Baldwin County. In 1991, a third artificial reef general-permit area (Hugh Swingle) was granted by the COE offshore Mobile County. In 1997, a proposal for extension of the three general permit areas was requested by the ADCNR and permits were issued that year by COE (Tatum, 1993). Alabama has used a large variety of materials (e.g., shell, concrete, automobile, vehicle tires, aircraft, railroad cars, steel and wooden vessels, oil and gas platforms, and military battle tanks) for reefs in its artificial reef program.

Florida

Florida's first permitted artificial reef site was issued in 1918 (Pybas, 1991). A rapid proliferation of artificial reef sites began in 1980. In the past 25 years, over 300 reef sites were established in State and Federal waters off 34 of Florida's 35 coastal counties on both the Gulf and Atlantic coasts, and more than 2,000 documented artificial reefs have been placed off Florida's coastal counties. Artificial reefs were built at water depths ranging from less than 3 m (10 ft) to greater than 200 m (656 ft). For the past 25 years, Florida's artificial reef program has been a cooperative effort of local governments and State agencies with additional input provided by nongovernmental fishing and diving interests. The Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries, manages the State's artificial reef program. The primary objective of the State's program has been to provide grants-in-aid to local coastal governments to develop artificial fishing reefs in State and adjacent Federal waters to increase local sportfishing resources and enhance sportfishing opportunities (Dodrill and Horn, 1996; Maher, 1999). Florida has used a large variety of materials previously mentioned for reefs within their artificial reef program.

Rigs-to-Reefs Development

Rigs-to-Reefs (RTR) is a catchy term for converting obsolete, nonproductive, offshore oil and gas platforms to designated artificial reefs (Dauterive, 2000). Offshore oil and gas platforms began functioning as artificial reefs in 1947 when Kerr-McGee completed the world's first commercially successful oil well in 5.6 m (18 ft) of water, 70 km (44 mi) south of Morgan City, Louisiana. Approximately 4,000 offshore oil and gas platforms exist on the Gulf of Mexico OCS beyond State territorial waters, with most (>90%) occurring offshore the States of Louisiana and Texas. Distribution of offshore platforms across the GOM is shown in **Figure A-5**. Placed with the primary intent of producing oil and/or gas, offshore platforms also provide artificial substrate and marine habitat where natural hard-bottom habitat is at a minimum. These platforms form the largest artificial reef complex in the world (Stanley and Wilson, 2000).

The BOEM regulations require that platforms be removed within one year after termination of the lease and the platform disposed onshore. Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry but can be a loss of productive marine habitat (Kasprazak and Perret, 1996). The use of obsolete oil and gas platforms for reefs has proven to be highly successful. Their availability, design profile, durability, and stability provide a number of advantages over the use of traditional artificial reef materials. To capture this valuable fish habitat, the States of Louisiana, Texas, and Mississippi in 1986, 1989, and 1999, respectively, passed enabling legislation and signed into law RTR plans for their respective States. Alabama and Florida have no RTR legislation; however, both States have oil and gas platforms in their programs. The distribution of RTR locations across the GOM is shown in **Figure A-6**.

The State laws set up a mechanism to transfer ownership and liability of the platform from oil and gas companies to the State when the platform ceases production and the lease is terminated. The company (donor) saves money by donating a platform to the State (recipient) for use as a reef rather than scrapping the platform onshore. The industry then donates 50 percent of the savings to the State to run the State's artificial reef program. Since the inception of the RTR plans, more than 240 retired platforms have been donated and used for reefs offshore of the Gulf Coast States. **Table A-3** shows the RTR donations by State.

A.5. OCS Lease and Permitting Activity and Related Infrastructure

As a matter of disclosure, BOEM's level of lease activity, approved applications to drill, permitting activity since the *Deepwater Horizon* event, and existing OCS offshore infrastructure are shown in **Figure A-5** and in **Tables A-4 through A-6**.

In the wake of the *Deepwater Horizon* event, BOEM has put in place significant new safeguards to protect the environment beyond what has ever existed. These new safety measures include heightened drilling safety standards to reduce the chances that a loss of well control might occur in the first place, as well as a new focus on containment capabilities in the event of an oil spill.

Deepwater drilling applications fall into two categories for the implementation of BOEM's new regulations. To clarify these differences, BOEM has included the narrative below. The deepwater moratorium was lifted on October 12, 2010, and is the point at which new rules were applicable in the applications.

- *Deepwater Permits Requiring Subsea Containment*: Since an applicant first successfully demonstrated containment capabilities in mid-February, BOEM has approved 90 of these permits for 27 unique wells, with 15 permits pending, and 28 permits returned to the operator with requests for additional information, particularly information regarding containment.
- *Deepwater Activities Not Requiring Subsea Containment*: Since the implementation of new safety and environmental standards, 45 of these permits have been approved, with 1 permit returned to the operator with requests for additional information. These activities include water injection wells and procedures using surface blowout preventers.

The distribution of OCS active platforms by water depth and structure type is shown in **Table A-6**, and their locations are shown on **Figure A-5**.

A.6. CLIMATE CHANGE

Climate change is included as an impacting factor in the cumulative analysis of some resources. The resources that include climate change as a cumulative impact factor meet one or both of the following two criteria:

- the resource is already experiencing impacts from climate change, so the effects are observable and not speculative; and
- the resource will be directly or indirectly affected by warming temperatures that can be projected.

Warming of the Earth's climate system is occurring, and most of the measured increase in average global temperature since the mid-20th century is attributed to the measured increase in anthropogenic greenhouse gas concentrations (Intergovernmental Panel on Climate Change, 2007). The NOAA's *State of the Climate* reports 10 indicators for a warming climate (Blunden et al., 2011; Cook, 2010a). All of these indicators are moving in the direction of the 10 indicators (up or down) and show conditions on the Earth's surface consistent with that of a warming planet.

1. Sea ice: down
2. Snow cover: down
3. Glaciers: down
4. Humidity: up
5. Temperature over oceans: up
6. Sea-surface temperature: up
7. Ocean heat content: up
8. Sea level: up
9. Temperature over land: up
10. Air temperature near surface (troposphere): up

The full body of evidence in climate science shows a number of distinct and discernable human fingerprints on climate change (Cook, 2010b). Among these would be

- cooling and shrinking upper atmosphere (satellite measurements show warming lower atmosphere, less heat to warm upper atmosphere, symptom of greenhouse gas trapping);
- less oxygen in the air (ratio of O_2/CO_2 decreasing);
- less heat escaping to space and more heat returning to Earth (satellite measurement of infrared radiation, greenhouse gases returning infrared radiation to Earth);
- nights warming faster than days and winter warming faster than summer (greenhouse gases inhibit heat radiating out to space);
- more fossil-fuel carbon in the air and in sea coral (ratio of Carbon_{13} to Carbon_{12} decreasing); and
- pattern of ocean warming (world's oceans warming from surface downward).

Globally, many environmental effects have been documented, including widespread changes in snow melt and ice cap extent; spatial changes in precipitation patterns; changes in the frequency of extreme weather events; changes in stream flow and runoff patterns in snow-fed rivers; warming of lakes and rivers, with effects on thermal structure and water quality; changes in the timing of spring events such as bird migration and egg laying; and poleward or altitude shifts in ranges of plant and animal species (Intergovernmental Panel on Climate Change, 2007). Documented changes in marine and freshwater biological systems are associated with rising water temperatures, as well as changes in salinity, oxygen levels, and circulation. These changes include shifts in ranges and changes in algal, plankton, and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers (Intergovernmental Panel on Climate Change, 2007).

The U.S. Global Change Research Program (2009) has summarized regional climate changes for the southeastern U.S. (including the Gulf Coast States). Since 1970, average annual temperature has risen approximately 2 °F (1.1 °C) and the number of freezing days has declined by 4-7 days per year. Average autumn precipitation has increased 30 percent since 1901. There has been an increase in heavy downpours in many parts of the region, while the percentage of the region experiencing moderate to severe drought increased over the past three decades. The area of moderate to severe spring and summer drought has increased by 12 percent and 14 percent, respectively, since the mid-1970's. Texas, Louisiana, and Oklahoma experienced severe drought conditions in 2011 (Blunden et al., 2011). Continuing changes in precipitation could affect the water quality and marine ecology of the GOM by altering the quantity and quality of runoff into estuaries.

Over the next century, the Intergovernmental Panel on Climate Change (2007) projects that global temperature increases will cause significant global environmental changes, including the following: reductions in snow cover and sea ice; more frequent extreme heat waves and heavy precipitation events; an increase in the intensity of tropical cyclones (hurricanes); and numerous hydrological, ecological, social, and health effects. Regionally, the U.S. Global Change Research Program (2009) predicts similar long-term changes for the southeastern U.S., including increased shoreline erosion because of sea-level rise and increases in hurricane intensity; heat-related stresses for people, plants, and animals; and decreased water availability because of increased temperature and longer intervals between rainfall events. The resilience of many ecosystems is likely to be stressed because of major changes in ecosystem structure and function, species' ecological interactions, and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity and ecosystem function (Intergovernmental Panel on Climate Change, 2007).

Reasonably foreseeable marine environmental changes in the GOM that could result from climate change over the next century include changes in sea level and shoreline configuration; increased levels of beach restoration activity (and increased use of OCS sand sources); changes in estuaries and coastal habitats due to interactive effects of climate change, along with development and pollution; and impacts on calcification in plankton, corals, crustaceans, and other marine organisms because of ocean acidification (The Royal Society, 2005).

Over the next two decades, the Intergovernmental Panel on Climate Change (2007) projected a warming of about 0.2 °C (32.4 °F) per decade; environmental changes in the GOM that result from climate change are likely to be small, incremental, and difficult to discern from effects of other natural and anthropogenic factors. While continuing climate change could result in changing regional ecological and socioeconomic patterns and distributions in the GOM, the rates and direction of many of these changes are somewhat speculative. The effects of climate change tend to be more pronounced at higher latitudes. These effects can be more subtle in the GOM with its subtropical climatic regime.

A.6.1. Physical Resources

Physical resources include (1) water quality, (2) air quality, and (3) acoustic environment. Climate change predictions are based on models that simulate all relevant physical processes under a variety of projected greenhouse gas emission scenarios. Because the complexity of modeling global and regional climate systems is so great, uncertainty in climate projections can never be eliminated. The Intergovernmental Panel on Climate Change's (2007) projections relating generally to water and water quality include the following:

- sea level will rise by 0.18-0.59 m (0.59-1.94 ft) by the end of the 21st century;
- sea ice, glaciers, and ice sheets in polar regions will continue melting;
- ocean pH will decrease by 0.14 to 0.35 over the 21st century;

- tropical cyclones will become more intense (>66% likely);
- precipitation will increase at high latitudes (>90% likely); and
- annual river discharges (runoff) will increase by 10-40 percent at high latitudes and decrease by 10-30 percent in the dry regions at mid-latitudes.

The Gulf of Mexico region has already experienced increasing atmospheric temperatures since the 1960's. From 1900 to 1991, sea-surface temperatures increased in coastal areas and decreased in offshore areas. Sea-level rise along the northern coast is as high as 0.01 m/yr (0.03 ft/yr), and it has contributed to the loss of coastal wetland and mangroves and increased the rates of shoreline erosion. Future sea-level rise is expected to cause saltwater intrusion into coastal aquifers, potentially making some unsuitable as potable water supplies. Significant changes (increases or decreases) in precipitation and river discharges to the Gulf of Mexico would affect salinity and water circulation, which, in turn, affects water quality. Water quality impacts associated with increased river discharges result from increases in nutrients (nitrogen and phosphorous) and contaminants to estuaries, increases in harmful algal blooms, and an increase in stratification. Such changes could also affect dissolved oxygen content and the extent of the Gulf of Mexico hypoxic zone. Decreased discharge would diminish the flushing of estuaries and increase concentrations of pathogens.

Air quality and the acoustic environment will not be directly or indirectly affected by warming temperatures of climate change.

A.6.2. Coastal and Estuarine Habitats

Coastal and estuarine habitats include (1) barrier islands, beaches, and dunes; (2) wetlands; and (3) submerged seagrass communities.

Indirect effects from global climate change include changes in temperature, rainfall, alteration in stream flow and river discharge, sea-level rise, changes in hurricane frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and subsidence (Yanez-Arancibia and Day, 2004). Potential thermal expansion of ocean water and the melting of glaciers and ice caps could result in a global rise in mean sea level according to the Intergovernmental Panel on Climate Change's projections. Recent rates of sea-level rise have been approximately 3 mm/yr (0.12 in/yr), but this rate may increase to 4 mm/yr (0.16 in/yr) by 2100 (Blum and Roberts 2009). Sea-level rise could result in increased inundation of barrier beaches and increases in losses of beach habitat. Effects of sea-level rise include damage from inundation, floods and storms, and erosion (Nicholls et al., 2007). Effects of increased storm intensity include increases in extreme water levels and wave heights; increases in episodic erosion, storm damage, risk of flooding, and defense failure (Nicholls et al., 2007). The small tidal range of the Gulf Coast increases the vulnerability of coastal habitats to the effects of climate change.

Patterns of erosion and accretion can also be altered along coastlines (Nicholls et al., 2007). Sea-level rise would result in greater inundation of coastal wetlands and likely result in an acceleration of coastal wetland losses, particularly in Louisiana, as wetlands are converted to open water. In addition, large changes in river flows into the Gulf could affect salinity and water circulation in estuaries, which, in turn, could impact estuarine wetland communities.

A study of coastal vulnerability along the entire U.S. Gulf Coast found that 42 percent of the mapped shoreline was classified as being at very high risk of coastal change due to factors associated with future sea-level rise (Thieler and Hammar-Klose, 2000). A revised coastal vulnerability index study of the coast from Galveston, Texas, to Panama City, Florida, indicated that 61 percent of that mapped coastline was classified as being at very high vulnerability, with coastal Louisiana being the most vulnerable area of this coastline (Pendleton et al., 2010).

A.6.3. Marine Benthic and Pelagic Habitats

Marine benthic and pelagic habitats include (1) topographic features and (2) chemosynthetic and nonchemosynthetic benthic communities.

In the benthic and pelagic habitats of the Gulf of Mexico, climate change may cause the temporal variability of key chemical and physical parameters—particularly hydrology, dissolved oxygen, salinity, and temperature—to change or increase, which could significantly alter the existing structure of the benthic and phytoplankton communities (Rabalais et al., 2010). For example, freshwater discharge into the Gulf of Mexico has been increasing, and it is expected to continue to increase as a result of the increased rainfall in the Mississippi River Basin (Dai et al., 2009). Such changes could result in severe long-term or short-term fluctuations in temperature and salinity that could reduce or eliminate sensitive species. Such changes are most likely to occur in the Mississippi Estuarine Ecoregion, where freshwater inputs are highest. In addition, greater rainfall may increase inputs of nutrients into the Gulf of Mexico, potentially resulting in more intense phytoplankton blooms that could promote benthic hypoxia (Rabalais et al., 2010). Hypoxic or anoxic conditions can reduce or eliminate the suitability of benthic habitat for marine organisms.

Climate change has the potential to profoundly affect coral communities in several ways including the following:

- increased frequency of bleaching as a stress response to warming water temperatures (Hoegh-Guldberg et al., 2007);
- excessive algal growth on reefs and an increase in bacterial, fungal, and viral agents (Boesch et al., 2000; Twilley et al., 2001);
- greater frequency of mechanical damage to corals from greater severity of tropical storms and hurricanes (Janetos et al., 2008);
- decreases in the oceanic pH and carbonate concentration are expected to reduce the reef formation rate, weaken the existing reef structure, and alter the composition of coral communities (Janetos et al., 2008); and
- platforms could accelerate the spread of invasive species that increase their range due to climate change.

As climate change has the potential to affect warm water corals, it could affect coldwater *Lophelia* reefs. The saturation depth of aragonite (the primary carbonate formed used by hard corals) appears to be a primary determinant of deepwater coral distribution, with reefs forming in areas of high aragonite solubility (Orr et al., 2005). The depth at which the water is saturated with aragonite is projected to become shallower over the coming century, and most coldwater corals may be in undersaturated waters by 2100 (Orr et al., 2005). Consequently, the spatial extent, density, and growth of deepwater corals may decrease, diminishing their associated ecosystem functions (Orr et al., 2005).

Chemosynthetic and nonchemosynthetic benthic communities will not be directly or indirectly affected by warming temperatures of climate change.

A.6.4. Marine and Coastal Fauna

Marine and coastal fauna include (1) marine mammals, (2) beach mice, (3) sea turtles, (4) fish and essential fish habitat, (5) coastal and marine birds, and (6) *Sargassum*.

Marine mammal populations throughout the Gulf may be adversely affected by climate change and, to a lesser extent, by hurricane events. There is growing evidence that climate change is occurring, and potential effects in the Gulf may include a change (i.e., rise) in sea level or a change in water temperatures. Such changes could affect the distribution, availability, and quality of feeding habitats and the abundance of food resources. The U.S. Global Change Research Program (2009) predicts increased shoreline erosion because of sea-level rise and increases in hurricane intensity and a precipitous decline in wetland-dependent fish and shellfish populations as a result of coastal marsh landlosses. Changes in sea level and shoreline configuration could adversely affect sea turtle nesting beaches, along with attempts to restore beaches.

Potential impacts on pelagic and water column invertebrates resulting from climate change include the following:

- an increase in the range and temporal variability of a water column’s oxygen, salinity, and temperature;
- a reduction in important estuarine habitats from sea-level rise;
- a range expansion of new species into the Gulf of Mexico;

- an increase in the extent and duration of Gulf of Mexico hypoxia that could kill or displace existing and suitable habitat areas; and
- reduced oceanic pH that could reduce the fitness of calcifying marine organisms such as echinoderms, zooplankton, and mollusks.

Beach mice populations may be affected by habitat fragmentation or inundation of the supratidal dunes where they live from rising sea levels. Fish and essential fish habitat, coastal and marine birds, and *Sargassum* will not be directly or indirectly affected by warming temperatures of climate change.

A.6.5. Social, Cultural, and Economic Resources

Social, cultural, and economic resources include (1) commercial and recreational fishing, (2) archaeological resources, (3) recreational resources, (4) human resources and land usage, and (5) environmental justice.

Rising relative sea levels and increased erosion have been observed all along the coast (Field et al., 2007). It is anticipated that climate change will result in increased temperatures and rising relative sea levels along the Gulf Coast, accompanied by an increase in severe storms in the coming decades. People who rely on commercial and recreational fishing are predicted to be most vulnerable to adverse effects resulting from these changes (Nicholls et al., 2007).

Archaeological resources, recreational resources, human resources and land usage, and environmental justice will not be directly or indirectly affected by warming temperatures of climate change.

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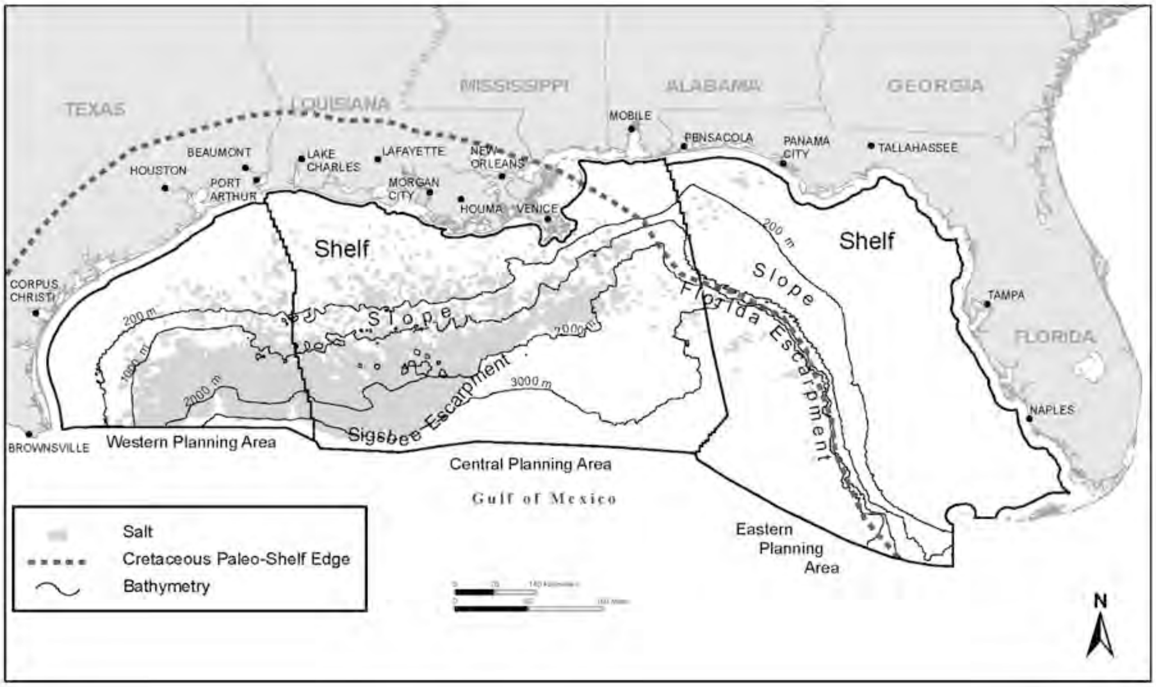

Figure A-1. Major Physiographic and Geologic Provinces of the Gulf of Mexico.

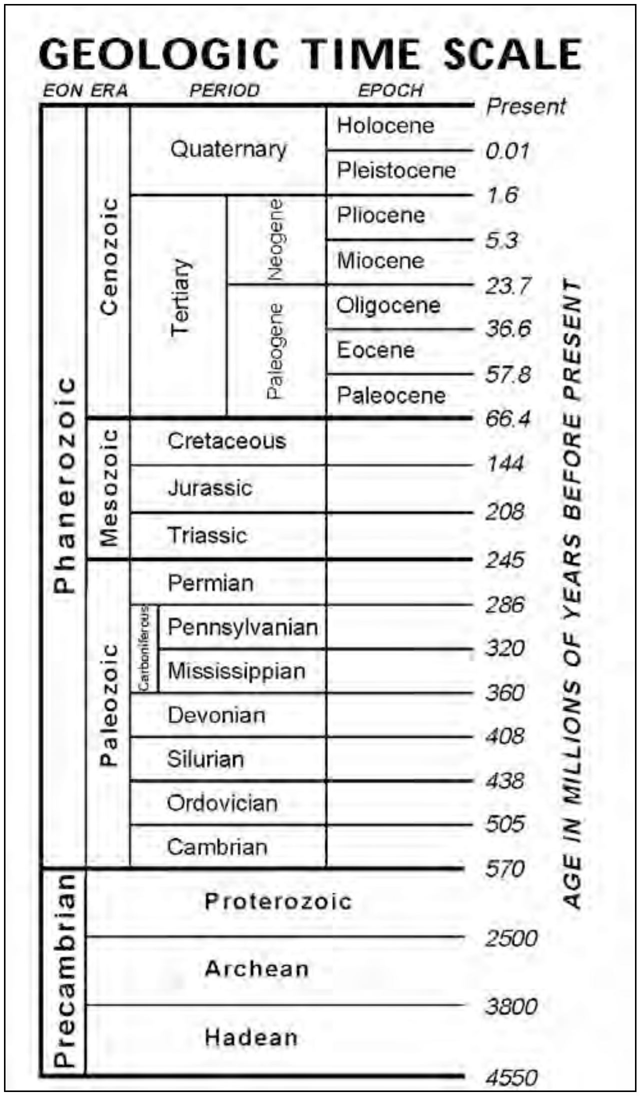

Figure A-2. Geologic Time Scale (Palmer, 1983).

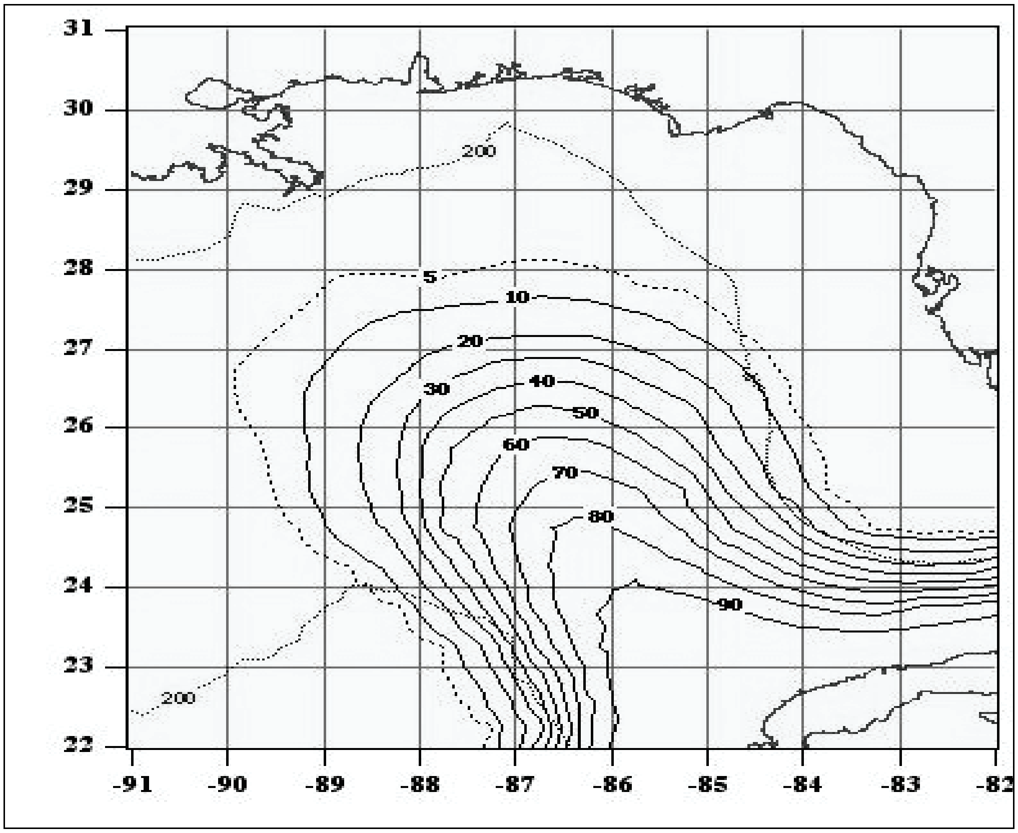

Figure A-3. Spatial Frequency (%) of the Watermass Associated with the Loop Current in the Eastern Gulf of Mexico based on Data for the Period 1976-2003 (Vukovich, 2005).

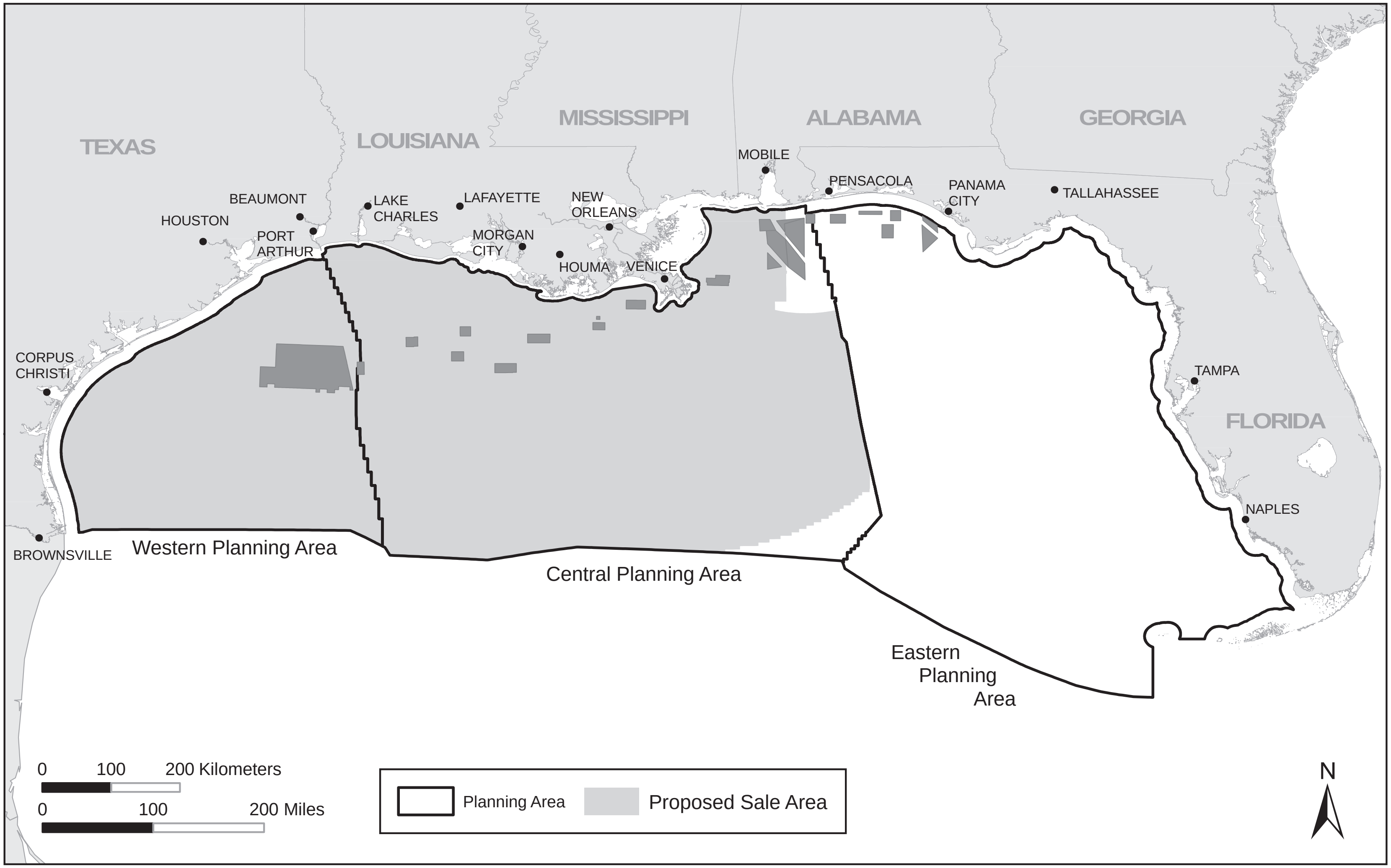

Figure A-4. Locations of Artificial Reef Planning Areas in the Gulf of Mexico.

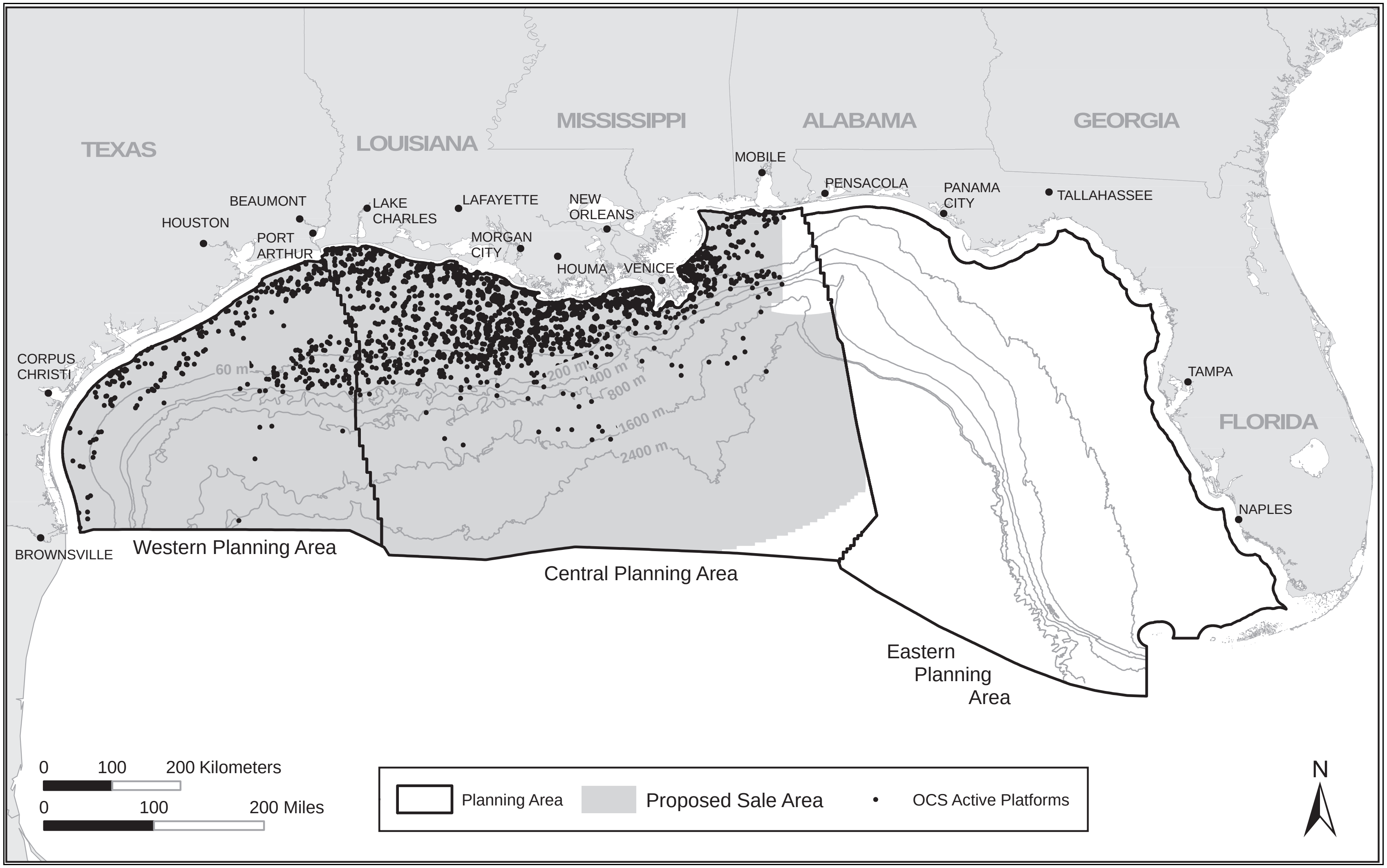

Figure A-5. OCS Platform Distribution across the Gulf of Mexico.

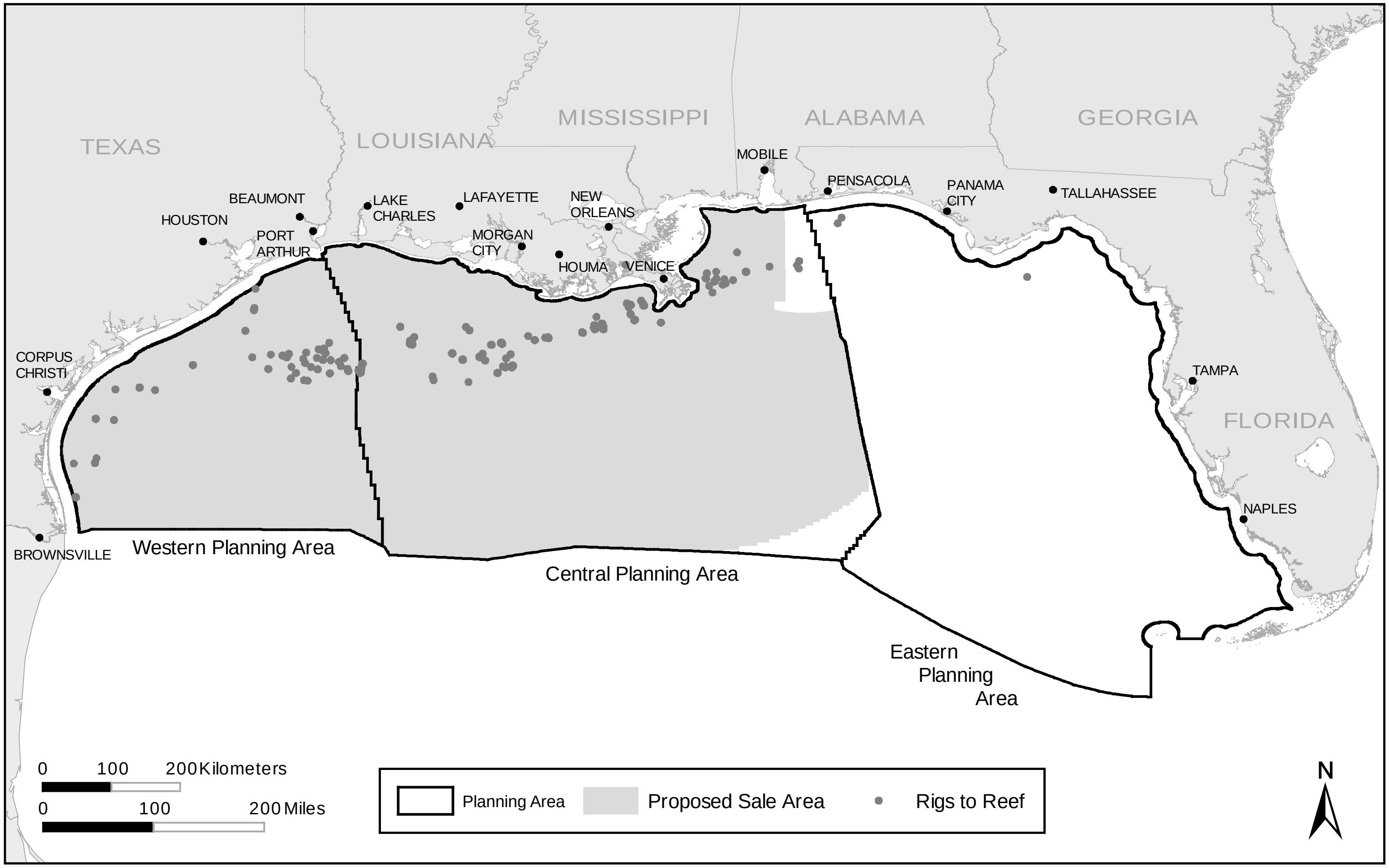

Figure A-6. Locations of Rigs-to-Reefs in the Gulf of Mexico.

Table A-1

Watermasses in the Gulf of Mexico

Watermass	Eastern Gulf of Mexico			Western Gulf of Mexico		
	Depth (m)	Feature(s)	Sigma-theta (m) (mg/cm^3)	Depth (m)	Feature(s)	Sigma-theta (m) (mg/cm^3)
SUW-LC	150-250	S_{max}	25.40	NA	NA	NA
SUW	150-250	S_{max}	25.40	0-250	S_{max}	25.40
18°C W	200-400	O_{2max}	26.50	NA	NA	NA
TACW	400-700	O_{2min}	27.15	250-400	O_{2min}	27.15
AAIW	NA	NA	NA	500-700	NO_{3max}	27.30
AAIW	700-900	PO_{4max}	27.40	600-800	PO_{4max}	27.40
AAIW	800-1,000	S_{min}	27.50	700-800	S_{min}	27.50
		SiO_{2max}	NA		SiO_{2max}	NA
UNADW	900-1,200	SiO_{2max}	27.70	1,000-1,100	SiO_{2max}	27.70

18^{o}C W = 18 degrees Centigrade Sargasso Sea Water
AAIW = Antarctic intermediate water
NA = information not available
NO_{3max} = nitrate maximum
O_{2max} = dissolved oxygen maximum
O_{2min} = dissolved oxygen minimum
PO_{4max} = phosphate maximum
SiO_{2max} = silicate maximum
S_{max} = salinity maximum
S_{min} = salinity minimum
SUW = subtropical underwater in the Gulf but outside the Loop Current
SUW-LC = subtropical underwater in the Loop Current and new Loop Current eddies
TACW = tropical Atlantic central water
UNADW = mixture of upper North Atlantic deep water and high-silicate Caribbean mid-water.

Table A-2

Climatological Data for Selected Gulf Coast Locations

Location	Precipitation (annual average) (m)	Temperature (mean annual) (^{o}C)	Wind Speed (average annual mean) (m/sec)	Humidity (average percent)	Barometric Pressure (average annual) (millibars)	Stability Conditions (Annual Percent)		
						Unstable	Neutral	Stable
Corpus Christi, TX	0.82	21.9	5.4	66-89	1,014	11.0	61.0	28.0
Galveston, TX	1.11	21.8	4.9	72-83	1,015	16.0	61.4	22.6
Lake Charles, LA	1.45	19.9	3.7	67-91	1,016	23.0	44.0	33.0
Gulfport, MS	1.65	20.1	3.9	62-87	1,016	17.5	47.4	35.1
Pensacola, FL	1.63	20.1	3.7	62-84	1,013	18.0	22.0	60.0
Key West, FL	0.99	25.6	4.9	68-80	1,014	80.0	18.0	2.0

Source: USDOC, NOAA, 2011.

Table A-3

Rigs-to-Reefs Donations and Methods of Removal and Reefing by State as of September 2011

State	Rigs-to-Reefs Donations	Tow-and-Place Platforms	Topple-in-Place Platforms	Partial Removal Platforms
Louisiana	270	167	56	47
Texas	154	85	31	38
Florida	3	3	0	0
Alabama	6	6	0	0
Mississippi	8	3	5	0
Total	441	264	92	85

Table A-4

Active Leases, Approved Applications to Drill, and Active Platforms by Water Depth

Water Depth (m)	Active Leases	Approved Applications to Drill	Active Platforms
0-200	1,919	33,833	3,167
201-400	129	1,111	20
401-800	287	835	10
801-1,000	391	512	7
≥1,000	3,271	1,657	26

Source: USDOI, BOEMRE, 2011a (data through August 8, 2011).

Table A-5

Summary of Approvals for Permits to Drill by Water Depth

Shallow Permits to Drill[1] (water depth ≤500 ft)						
Permit Type	Submitted Before June 8, 2010	Submitted Since June 8, 2010	Returned[2]	Withdrawn[3]	Pending[4]	Approved Since June 8, 2010[5]
New Well	13	74	8	5	7	67
Revised New Well	9	124		2		131
Bypass		29			1	28
Revised Bypass		20				20
Sidetrack	16	109	7	3	12	103
Revised Sidetrack	6	116	1			121
Deepwater Permits to Drill[6] (water depth >500 ft)						
Permit Type	Submitted Before Oct. 12, 2010	Submitted Since Oct. 12, 2010	Returned[2]	Withdrawn[3]	Pending[7]	Approved Since Oct. 12, 2010[8]
New Well	15	28	18	2	8	15
Revised New Well	2	67	5	3	4	57
Bypass		13				13
Revised Bypass	1	21	1	2		19
Sidetrack	4	14	4	1	3	10
Revised Sidetrack	4	19	1	1		21

[1]Shallow-water drilling operations became subject to new rules and information requirements as of June 8, 2010.
[2]Submitted permit applications may be returned to the operator for further information or clarification. These applications are not counted as pending applications.
[3]Applications may be withdrawn by an operator at any time in the application process.
[4]Pending permit numbers include applications submitted before and after June 8, 2010. They do not include applications that have been returned.
[5]Approved permit numbers include applications submitted before and after June 8, 2010.
[6]The deepwater moratorium was lifted on October 12, 2010, and is the reference for inclusion of new rules in the applications.
[7]Pending permit numbers include applications submitted before and after October 12, 2010. They do not include applications that have been returned.
[8]Approved permit numbers include applications submitted before and after October 12, 2010.

Source: USDOI, BOEMRE, 2011b.

Table A-6

Number of Active Platforms by Structure Type and Water Depth

Platform Type	Water Depth					
	0-60 m	60-200 m	200-400 m	400-800 m	800-1,600 m	1,600-2,400 m
Caisson	918	2				
Compliant Tower			1	2		
Fixed Leg Platform	1,632	405	19	1		
Mobile Production Unit	1			1		
Mini Tension-Leg Platform				1	4	
Semisubmersible Floating Production System					2	6*
Subsea Manifold						
Subsea Template						
SPAR Platform				3	9	4
Tension-Leg Platform				2	8	
Underwater Completion or Subsea Caisson						
Well Protector	284	14				

* One semisubmersible production system is in water depth of 2,038 m.

Source: USDOI, BOEMRE, 2011c.

APPENDIX B

CATASTROPHIC SPILL EVENT ANALYSIS

CATASTROPHIC SPILL EVENT ANALYSIS: HIGH-VOLUME, EXTENDED-DURATION OIL SPILL RESULTING FROM LOSS OF WELL CONTROL ON THE GULF OF MEXICO OUTER CONTINENTAL SHELF

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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) (see 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* (DWH) event and spill in the Gulf of Mexico (CEQ, 2010), recommended that the Bureau of Ocean Energy Management (BOEM), formerly the Minerals Management Service (MMS), should "ensure that 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 analysis provides that robust analysis of the impacts from low-probability catastrophic spills for 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 Gulf of Mexico Regional Supervisors, Office of Environment and Office of Leasing and Plans, for an exploration or development plan.

It should be noted that the analysis presented here is intended to be a general overview of potential effects of a catastrophic spill in the Gulf of Mexico. The analysis does not include detailed sale-specific or site-specific analyses nor is it intended to replace such analyses for individual resources in this EIS. 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 EIS analysis.

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, long-duration oil spill regardless of the cause, whether natural disaster (i.e., hurricane) or manmade (i.e., human error and terrorism). This high-volume, long-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 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 (i.e., speed and effectiveness). For this reason, the severity of impacts from of 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 of oil leaked (USDOI, BOEMRE, 2010a); 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.

Blowouts are a more severe loss of well control incident that creates a great 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. In 1979, the *Ixtoc* blowout in shallow water (water depth of 164 feet [ft]; 50 meters [m]; and 50 miles [mi]; 80 kilometers [km] offshore in the Bay of Campeche, Mexico) spilled 3.5 million barrels of oil in 10 months (USDOC, NOAA, Office of Response and Restoration, 2010a; USDOC, NOAA, Hazardous Materials Response and Assessment Division, 1992; ERCO, 1982). On April 20, 2010, the DWH event, in deep water (4,992 ft; 1,522 m) 48 mi (77 km) offshore in Mississippi Canyon Block 252, spilled an estimated 4.9 million barrels of oil until it was capped almost 3 months later.

Prior to the DWH event, 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 barrels of oil, respectively (USDOI, BOEMRE, 2010b). These incidents resulted in four human fatalities. Although these incidents occurred only 8-14 mi (13-26 km) from shore, there was minor shoreline contact with oil (USDOC, NOAA, Office of Response and Restoration, 2010b and 2010c). In 1987, a blowout of the Mexican exploratory oil well, YUM II, resulted in a spill of 58,640 barrels and 75 mi of impacted shoreline (USDOC, NOAA, Hazardous Materials Response and Assessment Division, 1992). None of these spills met the definition of a catastrophic event or spill. For this reason, only the *Ixtoc* and DWH blowouts and spills are analyzed below.

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, sea turtles, etc.). 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, it is 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.

1.2.1. Geographic Scope

The Gulf of Mexico is a semi-enclosed basin with an extensive history of oil and gas activities and with 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.

When possible, this analysis distinguishes between shallow water (<1,000 ft; 305 m) and deep water (≥1,000 ft; 305 m).

1.2.2. Impact-Producing Factors and Scenario

A hypothetical, yet feasible, scenario was developed to provide a framework for identifying the impacts of an extended oil spill from an uncontrolled blowout in both shallow and deep water. Unless noted, this scenario is based on the larger magnitude, blowout-related oil spills that have occurred in the Gulf of Mexico (discussed in Section 1.1). As noted above, because each spill event is unique, its outcome depends on many factors. Therefore, the impacts from present or future spills cannot be predicted based on this scenario.

1.2.3. Environmental and Socioeconomic Impacts

This analysis evaluates the impacts to the Gulf of Mexico's coastal, marine, environmental, 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), the analysis below 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 individual resource.

1.3. HOW TO USE THIS ANALYSIS

The purpose of this technical analysis is to assist BOEM in meeting CEQ requirements. 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). "'Reasonably foreseeable' impacts include impacts which 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, 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 proposed action.

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 are highlighted throughout the analysis 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 distance to shore of the proposed activities.

The life cycle of a catastrophic blowout and spill is divided into four geographic areas and/or time periods, some of which may overlap:

- Phase 1: Initial event (Section 2)
- Phase 2: Offshore spill (Section 3)
- Phase 3: Onshore contact (Section 4)
- Phase 4: Post-spill, long-term recovery (Section 5)

Each phase of a catastrophic oil spill is addressed in this analysis. For each phase, the scenario is described, factors that could produce environmental impacts are listed, and the most likely and most significant impacts are discussed.

2. INITIAL EVENT (PHASE 1)

While most of the environmental and socioeconomic impacts of a catastrophic blowout would occur during the ensuing high-volume, extended-duration spill (see Sections 3, 4, and 5), 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.

2.1. IMPACT-PRODUCING FACTORS AND SCENARIO

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. 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 1 below.

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 (USDOC, NOAA, Office of Response and Restoration, 2010c). 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, the DWH drilling rig sank, landing 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, and firefighting vessels.

Table 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 may reduce impacts to coastal ecosystems; however, their use may increase exposure of marine resources to 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 dispersants 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.

2.2. Most Likely and Most Significant Impacts

Impacts during Phase 1 would be limited to environmental resources in the immediate vicinity of the blowout. The most recent EIS's prepared by this Agency for oil and gas lease sales in the Gulf of Mexico detail the potential impacts from reasonably foreseeable blowouts (USDOI, MMS, 2007 and 2008). In addition to the impacts described in those documents, the most likely and most significant impacts resulting from a catastrophic blowout outside the wellbore are described below.

2.2.1. Physical Resources

2.2.1.1. Air Quality

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 DWH oil spill (de Gouw et al., 2011), during which the lightest compounds, the VOC's, in the oil from the DWH blowout evaporated within hours and during which the heavier compounds took longer to evaporate, contributing to the formation of air pollution particles downwind.

2.2.1.2. Offshore Water Quality

During the initial phase of a catastrophic blowout, water quality impacts include disturbance of sediments and release and suspension of oil and natural gas (methane) into the water column. These potential impacts are discussed below. As this section deals with the immediate effects of a blowout that would be located at least 3 nautical miles 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 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 even days. Bottom currents in the deep Gulf of Mexico have been measured to reach 30 centimeters/second (cm/sec) (12 inches/second [in/sec]) with mean flows of 1.5-2.5 cm/sec (0.6-0.9 in/sec) (Hamilton, 1990). At these mean flow rates, resuspended sediment could be transported 1.3-2.1 kilometers/day (0.8-1.3 miles/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

As the DWH event showed, 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) 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.

Large quantities of oil put into offshore water may alter the chemistry of the sea with unforeseeable results. The VOC's, including benzene, can have acutely toxic effects. The components of crude oil that are water soluble are more available than some of the heavier components to exert a toxic effect on marine life. The PAH's are present in crude oil and include carcinogenic compounds and compounds that pose various risks to marine organisms and possibly to the higher trophic level species, including humans that feed on these organisms. The PAH's are also persistent in the environment. Impacts from the subsequent extended oil spill on offshore water quality are discussed further in Section 3.2.1.2.

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 (NaturalGas.org, 2010). Methane may stay in the marine environment for long periods of time (Patin, 1999; p. 237), as methane is highly soluble in seawater at the high pressures and cold temperatures found in deepwater environments (NRC, 2003;

p. 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; p. 23). In addition to methane, natural gas contains smaller percentages of other gases such as ethane and propane. It may also contain VOC's (including benzene, toluene, ethylbenzene, and xylene) and H_2S, which have individual toxic characteristics. Methane and other natural gas constituents are carbon sources, and their introduction into the marine environment could result in reducing the dissolved oxygen levels because of microbial degradation of the methane potentially creating hypoxic or "dead" zones. Depletion of dissolved oxygen in the Gulf of Mexico because of the release of natural gas from the Macondo well (DWH event) is currently being examined as a result of the DWH event (Schenkman, 2010). 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 (see Section 3.2.2.2).

2.2.2. Biological Resources

Impacts during the initial event would be limited to environmental resources in the immediate vicinity of the blowout as described below.

2.2.2.1. Marine and Migratory Birds

Many migratory birds use offshore platforms or rigs as rest sites during migration (Russell, 2005). In addition, seabirds are attracted to offshore platforms and rigs (Tasker et al., 1986; Wiese et al., 2001). The numbers of birds present at a platform or rig are greater when platforms or rigs are closer to shore during drilling operations (Baird, 1990). Birds resting on the drilling rig or platform during a catastrophic blowout are likely to be killed by an 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 conceivable that the light from the fire could interfere with nocturnal migration, especially during poor visibility conditions. 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 throughout the year, the largest number of species migrates from March through November. A blowout during this time would cause a greater number of bird fatalities. While the number and species of birds killed depends on the blowout location and time of year, these initial fatalities would likely not result in population-level impacts for species present at the time of the blowout and resulting fire (Russell, 2005, Table 6.12).

2.2.2.2. Fish, Fisheries, and Essential Fish Habitat

Depending on the type of blowout and the proximity of marine life to it (Table 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. Offshore benthic habitats that support fisheries could also be impacted, as discussed below.

2.2.2.3. Marine Mammals

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.

2.2.2.4. Sea Turtles

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 (Table 1), 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.

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.

2.2.2.5. Offshore Benthic Habitats

Gulf of Mexico benthic resources are divided into shelf habitats and deepwater habitats. Shelf habitats of the Gulf of Mexico include soft-bottom habitats (sandy and muddy substrate) and hard-bottom habitats (rock or salt outcroppings that provide habitat for encrusting organisms). Deepwater benthic communities of the Gulf of Mexico include soft-bottom, coral, and chemosynthetic habitats. The impacts to these benthic communities depend on the location and the type of catastrophic blowout that occurs.

Introduction

Sediment disturbance as a result of the blowout above the seafloor would not occur. 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 result in released oil rising to the sea surface. However, if the leak is deep in the water column and the oil is ejected under pressure, oil droplets may become entrained deep in the water column. The upward movement of the oil may be reduced if methane in the oil is dissolved at the high underwater pressures, reducing the oil's buoyancy (Adcroft et al., 2010). The large oil droplets will rise to the sea surface, but the 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). Oil droplets less than 100 micrometers in diameter may remain in the water column for several months (Joint Analysis Group, 2010a), where they will not be in contact with benthic habitats; similarly, large oil drops on the sea surface will not be in contact with benthos. However, oil in the water column or at the sea surface may sometimes sink, contact benthos, and have impacts, as discussed below.

As discussed below, 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 of the sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities.

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.

Soft-Bottom Shelf Habitats

The vast majority of the Gulf of Mexico seabed is comprised of soft sediments. Microbes to metazoans (e.g., polychaete worms and crabs) inhabit the soft-bottom benthos, many forming the base of the food chain for several species. When soft-bottom infaunal communities are physically impacted by a blowout (either lost to the crater formation or smothered by sediment), recolonization by populations from neighboring soft-bottom substrate is expected within a relatively short period of time. 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 (Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). A slow recovery rate will result in a community with reduced biological diversity and possibly a lesser food value for predatory species.

Hard-Bottom Shelf Habitats

The Gulf of Mexico has several hard-bottom features on the continental shelf in water depths less than 300 m (984 ft), features upon which encrusting and epibenthic organisms attach. Though there are varying degrees of relief on the hard bottom, the impacts from a catastrophic blowout are similar for the banks of varying relief because similar organisms occur on these features. Thus, they are discussed as a single grouping under "hard-bottom communities," with references to specific communities where impacts may differ.

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 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 National Marine Sanctuary. The BOEM has created "No Activity Zones" around topographic features in order to protect these habitats from disruption because of 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 policy. Notice to Lessees and Operators (NTL) 2009-G39 recommends that drilling should not occur within 152 m (500 ft) of a "No Activity Zone" of a topographic feature.

The northeastern portion of the central Gulf of Mexico is a region of low to moderate relief known as the "Pinnacle Trend" at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon. Fish are attracted to these outcrops that provide hard substrate for sessile invertebrates to attach. The NTL 2009-G39 recommends that no bottom-disturbing activities occur within 30 m (100 ft) of any hard bottoms/pinnacles with a relief of 8 ft (2 m) or greater.

Potentially sensitive biological features are features that have moderate to high relief (8 ft [2 m] or higher), provide hard surface for sessile invertebrates, attract fish, but are not located within Pinnacle-designated blocks or the "No Activity Zone" of topographic features. No bottom-disturbing activities that may cause impact to these features are permitted.

Impacts that occur to hard-bottom shelf habitats 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 hard-bottom habitat 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." 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). These long-term impacts, such as reduced recruitment success, reduced growth, and reduced coral cover, as a result of impaired recruitment, are discussed in Section 3.2.2.6. 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 other hard-bottom substrate.

Benthic communities on a hard-bottom feature 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 to death (Rogers, 1990).

The initial blowout impact would be greatest to communities located in clear waters that experience heavy sedimentation. 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 would not be 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. It is possible, however, for potentially sensitive biological features outside of "No Activity Zones" or Pinnacle-designated blocks to experience some turbidity or sedimentation impacts. 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).

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 (40 mi) east of the mouth of the Mississippi River and trending to the northeast. 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 they 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 communities (hard- or soft-bottom communities) on the seafloor upon which the rig settles would be destroyed or smothered. A settling rig may suspend sediments, which may smother nearby benthic communities as the sediment is redeposited on the seafloor. 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.

Deepwater Habitats

The effects of a catastrophic blowout event on Gulf of Mexico benthic resources in deep water (>1,000 ft; 300 m) are similar to those on the shelf communities. The main factors are the type of blowout and the proximity to the habitat. Known deepwater communities include soft bottoms and two types of hard-bottom communities: chemosynthetic communities and deep coral 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. 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.

The BOEM's restrictions applicable to work near deepwater hard-bottom areas (as described in NTL 2009-G40) would prevent direct negative effects from a seafloor blowout. The established policy prohibits location of wells within 2,000 ft (610 m) of a suspected hard-bottom habitat. Geophysical analyses have achieved a high degree of reliability in detecting the potential presence of hard-bottom communities in the Gulf of Mexico. In rare instances, the subtle geophysical signatures of hydrocarbon seepage that are a probable indicator of a hard-bottom community are not discovered during routine environmental analysis. Therefore, it is possible that a well could be drilled close enough for a hard-bottom community to be damaged in the event of a catastrophic blowout.

Blowouts at points above the seafloor (in the riser or on the drill platform) would have little immediate effect on deepwater seafloor communities unless the structure sinks and physically impacts the seafloor. If a structure sank directly on a hard-bottom community, at least 2,000 ft (610 m) from the well, organisms could be crushed and smothered.

2.2.3. Socioeconomic Resources

2.2.3.1. Offshore Archaeological Resources

The 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 nautical miles. 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 in 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 EP, DOCD, or DPP, 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 the proposed action area to determine if additional archaeological resource surveys and mitigations are warranted.

2.2.3.2. Commercial Fishing

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.

2.2.3.3. Recreational Resources and Fishing

A substantial amount of recreational activity is associated in the immediate area around shallow water oil and gas structures because these structures function as artificial reefs, promote coral growth, and attract fish. About 20 percent of the recreational fishing activity and 90 percent of the recreational diving 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 within 100 mi (161 km) of shore could endanger recreational fishermen and divers in the immediate vicinity of the blowout, especially if the blowout is located between water depths of 100 and 200 ft (30 and 61 m). Recreational vessels in the area would likely aid in initial search-and-rescue operations but would also be in danger during the explosion and subsequent fire. The subsequent fire could burn for more than a month, during which recreational vessels would be expected to avoid the area and not interfere with response activities. This will impact the income of recreational fishing and diving businesses. Also, if the fire and smoke is visible from recreational beaches, their recreational use may be impacted.

2.2.3.4. Human Resources, Land Use, and Environmental Justice

Fatalities and serious injuries would likely occur during the initial explosion and/or fire. Due to the large number of people (>100) working on a deepwater drilling rig or platform, dozens of fatalities and serious injuries could occur.

With the explosion >3 nautical miles from the shore and the likelihood that the resulting fire will burn for a short duration, the initial fire and/or explosion is not expected to impact land use, demographics, or economics, although some recreational beach use may be impacted (Section 2.2.2.3). Thus, the initial fire and explosion should not disproportionately affect low-income persons or minorities, and therefore, will not raise environmental justice concerns.

3. OFFSHORE SPILL (PHASE 2)

3.1. IMPACT-PRODUCING FACTORS AND SCENARIO

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters.

3.1.1. 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 problems 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 DWH event. Assuming the duration of previous spills including the DWH and the type of oil and water temperatures found in the Gulf of Mexico, the majority of visibly spilled oil on the surface of the water would not persist more than 30 days after the oil flow stopped (Lubchenco et al., 2010).

3.1.1.1. Shallow Water

If a blowout occurs in shallow water, the entire intervention effort including drilling relief wells could take 1-3 months. This includes 1-3 weeks to transport the drilling rig to the well site. Spilled surface oil is not expected to persist more than 1 month after the flow is stopped. Therefore, the estimated spill duration resulting from a shallow water blowout is 2-4 months.

3.1.1.2. Deep Water

If a blowout occurs in deep water, the entire intervention effort including drilling relief wells 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 month after the flow is stopped. Therefore, the estimated spill duration from a deep water blowout is 4-5 months.

3.1.2. Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of spreading depends on the type and volume that is spilled. However, 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.

3.1.3. Volume of Spill

For this analysis, a higher flow rate is assumed for a blowout in deep water for the following reasons. After 50 years of Gulf of Mexico development, most, if not all, of the largest shallow-water prospects have been developed. As a result, reservoir pressures in shallow water are generally reduced. Although under certain conditions oil may be present with the natural gas, deeper shelf wells target natural gas. Also, because deepwater development is costly, only larger prospects with higher flow rates are currently targeted for exploration.

3.1.3.1. Shallow Water

For this analysis, an uncontrolled flow rate of 30,000 barrels per day is assumed for a catastrophic blowout in shallow water. This assumption is based upon the results of well tests in shallow water (see Section 3.1.3 above) and the maximum flow rate from the 1979 *Ixtoc* 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 to 3 million barrels for a spill lasting 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.

3.1.3.2. Deep Water

For the purposes of this analysis, an uncontrolled flow rate of 30,000-60,000 barrels per day is assumed for a catastrophic blowout in deep water. This flow rate is based on the assumption in Section 3.1.3 above, well test results, and the maximum flow rate estimated for the 2010 DWH event, which occurred in deep water. Therefore, total volume of oil spilled is estimated to be 2.7-7.2 million barrels over 3-4 months. In addition, deepwater drilling rigs or platforms hold a large amount of diesel fuel (10,000-20,000 barrels). Therefore, it is assumed that any remaining diesel fuel from a sunken structure would also leak and add to the spill.

3.1.4. 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; p. 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

- evaporation (volatilization),
- emulsification (the formation of a mousse),
- dissolution,
- oxidation, 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 below in Table 2.

Table 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 mg/L)	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

Sources: Michel, 1992; Canadian Center for Energy Information, 2010.

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 and, therefore, it is not analyzed in this paper (USDOI, BOEMRE, 2010c).

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 DWH event challenge that theory. While analyses are in their preliminary stages, it appears that measurable amounts of hydrocarbons (dispersed or otherwise) are being 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 (DWH event), 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.

3.1.5. 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, 2010).

3.1.6. Offshore Cleanup Activities

As demonstrated by the *Ixtoc* and DWH spill responses, a large-scale response effort is certain to follow a catastrophic blowout. The number of vessels and responders would increase exponentially as the spill continued.

3.1.6.1. Shallow Water

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 a 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.

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 dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities.

Up to 25 planes and 50 helicopters are estimated to respond per day by the end of a shallow-water spill.

Along the Gulf Coast, dispersants are preapproved for use greater than 3 nautical miles from shore and in water depths greater than 33 ft (10 m), with the exception of Florida where the water depth must be 65 ft (20 m) (U.S. Dept. of Homeland Security,(USDHS), CG, 2010). However, the U.S. Environmental Protection Agency (USEPA) is presently examining these preapprovals, and restrictions are anticipated regarding the future use of dispersants for ongoing spills as a result. Changes to the dispersant use preapprovals would be expected to limit this use in the future. Under the preapprovals, it is estimated that up to a total of 35,000 barrels of dispersant would be used.[1] Aerial dispersants would likely be applied from airplanes as a mist, which settles on the oil on the water's surface. In addition to dispersants, controlled burns may also occur.

3.1.6.2. Deep Water

Within the first week of 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 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 (USDHS, CG, 2010). However, USEPA is presently examining these preapprovals, and restrictions are anticipated regarding the future use of dispersants as a result. Under preexisting preapprovals, it is estimated that up to 50,000 barrels of dispersant could be applied (2/3 on the water surface and 1/3 subsurface, if possible). Changes to the dispersant use preapprovals would be expected to limit this use. 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 1. Aerial dispersants are

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1 At the *Ixtoc-I* well blowout in 1979, between 1 million and 2.5 million gallons of mostly Corexit dispersant products were applied over a 5-month period on the oil discharge. However, this scenario assumes a spill from a blowout in shallow water would last up to 3 months.

applied from airplanes as a mist, which settles on the oil on the water's surface. In addition to dispersants, 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.

3.1.6.3. Vessel Decontamination Stations

To avoid contaminating inland waterways, multiple vessel decontamination stations may be established offshore in Federal and State waters. 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 in deep water (Alabama State Port Authority, 2010; State of Florida, Office of the Governor, 2010; Nodar, 2010; Unified Incident Command, 2010a-c; USDOC, NOAA, 2010a; USEPA, 2010a).

3.1.7. Severe Weather

A hurricane could accelerate biodegradation, increase the area affected by the spill, and/or slow the response effort. The Atlantic hurricane season runs from June 1st through November 30th, peaking 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, 2010a). 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, 2010b). The high winds may distribute oil over a wider area (USDOC, NOAA, National Weather Center, 2010b). 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.

3.2. MOST LIKELY AND MOST SIGNIFICANT IMPACTS

The most recent EIS's prepared by this Agency for oil and gas lease sales in the Gulf of Mexico identify in detail the potential impacts from reasonably foreseeable oil spills (USDOI, MMS, 2007 and 2008). In addition to the impacts described in those documents, the most likely and most significant impacts because of the magnitude of shoreline oil as a result of a catastrophic spill are described below.

3.2.1. Physical Resources

3.2.1.1. Air Quality

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 fractions 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 out of high exposure areas, and pointing vessels into the wind. During the DWH event, air samples collected by individual offshore workers of British Petroleum (BP), the Occupational Safety and Health Administration (OSHA), and U.S. Coast Guard showed levels of benzene, toluene, ethylbenzene, and xylene that were mostly under detection levels. All samples had concentrations below the OSHA Occupational 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 from shore, the oil slick would not normally have any effects on onshore ozone concentrations.

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 barrels of oil for a spill of 60,000 barrels per day for 120 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 DWH event, 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 barrels 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.

3.2.1.2. 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; p. 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). 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 (The Federal Interagency Solutions Group, 2010). 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 photooxidation 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. As a result, clouds or plumes of dispersed oil may occur near the blowout site. Reports following the DWH event have found such plumes and have shown that the concentrations of these clouds decrease to undetectable levels within a few miles of the source (USDOC, NOAA, 2010b). Additional reporting in the coming months will enhance the understanding of the effects of subsurface plumes. Dissolved oxygen levels are a concern with any release of a carbon source, and these levels became a particular concern during the DWH event, since dispersants were used in deep waters for the first time. Thus, USEPA required monitoring protocols in order to use subsea dispersants

(USDOC, NOAA, 2010c). 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 Gulf of Mexico; however, scientists reported that these levels have stabilized and are not low enough to be considered hypoxic (USDOC, NOAA, 2010d). The temporary decrease in oxygen content has been attributed to microbial degradation of the oil. Over time, as the oil continues to be degraded and diffuses, hypoxia becomes less of a concern. As reported for the DWH event, dissolved oxygen levels would likely remain above levels of immediate concern, but there would still be a need to monitor dissolved oxygen levels over time.

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).

3.2.2. Biological Resources

The most recent EIS's prepared by this Agency for oil and gas lease sales in the Gulf of Mexico details potential localized impacts to specific species from reasonably foreseeable oil spills (USDOI, MMS, 2007 and 2008). However, a catastrophic event, such as a high-volume, extended-duration spill resulting from a blowout, has the potential to cause population-level impacts. Multiple Federal and State-listed, threatened and endangered species could be impacted from an extended offshore spill (USDOI, FWS, 2010a and 2010b).

3.2.2.1. Marine and Migratory Birds

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 related to their behavior. 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, or resting and preening (e.g., diving ducks, cormorants, pelicans, etc.) are highly vulnerable to becoming oiled and also to ingesting oil, as are black skimmers. These birds tend to feed and concentrate in convergence zones, places in the ocean where strong opposing currents meet. In addition to concentrating prey, these zones also 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 maintain body heat. Attempts by the birds to remove the oil by preening causes oiled birds to ingest oil and may result in mortality.

3.2.2.2. Fish, Fisheries, and Essential Fish Habitat

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). There is a high probability of mortality for the eggs and larvae of Gulf fishes that come in contact with spilled oil.

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. There were, however, sightings of whale sharks (which are defined as "threatened" by the International Union for Conservation of Nature) swimming among slicks from the DWH spill. They were not visibly oiled, but there was concern that they could be affected because they are surface feeders (Howell, 2010). Effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes (internal lesions), effects of direct coating by oil (suffocation by coating gills), incorporation of hydrocarbons in organisms causing tainting or accumulation in the food chain, and changes in biological habitat (decreased dissolved oxygen) (Moore and Dwyer, 1974).

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. 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 of the combination of factors is difficult to determine. The combined toxic effects of the oil and any dispersants that may be used may 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).

Recent studies by USEPA 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 acute toxicity on three cell lines over a range of concentrations and (2) evaluate 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 parts per million (ppm). Results of the *in vitro* toxicity tests were similar to the whole animal tests, showing generally low dispersant toxicity. Lethal concentration (LC_{50}) values (the concentration at which half of the test subjects die) were lower than the cell-based assays. 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 silverside fish and the mysid shrimp 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, 2010a and 2010b).

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. Spawning is clustered in a specific type of habitat along the continental slope. Bluefin tuna are among the most valuable fish in global markets. The International Commission for the Conservation of Atlantic Tunas (ScienceDaily, 2010) currently manages the Atlantic bluefin tuna as two distinct populations, with western Atlantic spawners of the Gulf of Mexico forming a population genetically distinct from the eastern spawners of the Mediterranean Sea. The western Atlantic stock has suffered, and a long-term rebuilding plan has failed to revive the population or the fishery. The failure of the Gulf of Mexico spawning population to rebuild and the scope of illegal and under-reported catches are of such concern that the species was considered for Appendix 1 listing (most endangered status) by the Convention of International Trade in Endangered Species (CITES) in March 2010. The NOAA made a determination on May 27, 2011, that Atlantic bluefin tuna did not warrant species protection under the ESA at that time. However, NOAA does plan to revisit this decision by early 2013 when more information will be available concerning any effects of the DWH spill (76 FR 31556). In addition, a new stock assessment will be available from the International Commission for the Conservation of Atlantic Tunas.

A catastrophic deepwater spill could release natural gases with methane as the primary component (NaturalGas.org, 2010) into the water column, but little is known about the effects of elevated methane levels on fish. Patin (1999) studied the elevated concentrations of methane resulting from a gas blowout from drilling platforms in the Sea of Asov, Ukraine, on fish. The pathological changes reported were species specific and included damages to cell membranes, organs, and tissues; modifications of protein synthesis; and other anomalies typical for acute poisoning of fish. These impacts, however, were observed at levels of 4-6 milligrams/liter of methane near the accident well. The full effect of elevated methane levels on Gulf of Mexico fishes is currently unknown.

3.2.2.3. Marine Mammals

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 (MMPA) 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 either entirely unknown PBR's or population size estimates that are more than 8 years old and therefore considered unknown. 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.

According to the Consolidated Fish and Wildlife Collection Reports from the DWH event, 170 marine mammals have been collected (13 alive, 157 deceased as of April 20, 2011). 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). The mortality estimates from the DWH event are just an example of the potential losses because of a high-volume oil spill. 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 DWH event. Thus, a high-volume oil spill lasting 120 days could directly impact as many individuals or more. The majority would likely be coastal or estuarine bottlenose dolphins, as was the case with the DWH event. This number represents only those marine mammals collected (either dead or alive) and does not address all potential impacts to the population. Based on these data, it is reasonable to assume that a catastrophic oil spill lasting up to 120 days could have population-level effects on many species of marine mammals (e.g., sperm whales, Bryde's whales, etc.).

3.2.2.4. Sea Turtles

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.

Based on the Consolidated Fish and Wildlife Collection Reports from the DWH event, a few to over two dozen sea turtles could be impacted daily through oiling and/or collection. According to the Consolidated Fish and Wildlife Collection Report, after the DWH event, 1,149 sea turtles have been collected (536 alive, 613 deceased as of April 20, 2011). These mortality estimates from the DWH event are just an example of the potential losses because of a high-volume oil spill. 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 DWH event. A high-volume oil spill lasting 120 days could impact greater than 1,000 sea turtles, and the majority could be Kemp's ridley turtles, which are listed as endangered under the ESA (USDOC, NOAA, NMFS, 2010a; Unified Incident Command, 2010e). In addition, the large number of response vessels could place sea turtles at a greater risk of vessel collisions, which could cause fatal injuries.

3.2.2.5. Offshore Habitats

Sargassum mats, which are mats made from a free-floating seaweed, provide habitat for juvenile sea turtles and developing invertebrates, spawning sites for hundreds of fish species, and feeding sources for manatees. In offshore waters, both free-floating patches of *Sargassum* seaweed and spilled oil tend to accumulate in convergence zones, places in the ocean where strong opposing currents meet. Sea turtles, especially juveniles, use these areas for food and cover. Burn operations sometime occurred there because of the aggregated oil (Unified Incident Command, 2010d). Benthic resources are discussed below.

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. 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). A study by Widger et al. (2011) does not support an argument of lasting effects because of the DWH spill on coastal microbial communities and pathogens. The study had only one pre-spill and one during-spill-time point each, with no post-spill component to monitor trends. Further, the pathogens noted are commonly found in coastal waters after significant rain events and occur as a result of untreated freshwater reaching the coast (Stumpf et al., 2010; Wetz et al., 2008; Hsieh et al., 2007). The study does not address the potential that the increase in microbial pathogens are a result of storm-water runoff, and it does not address if there was a significant rain event upstream, which could have carried these terrestrial derived pathogens to the coastal zone.

3.2.2.6. Continental Shelf Benthic Resources

A spill from a shallow-water blowout could impact benthic communities on the continental shelf because of the blowout's proximity to these habitats. A spill from a deepwater blowout could also impact shelf communities if oil that was chemically dispersed at the seafloor is transported to these areas.

Soft-Bottom Benthic Communities

Soft-bottom infaunal communities that come into direct contact with oil or dispersed oil may experience sublethal and/or lethal effects. 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; 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).

Long-term or low-level exposure may occur to benthic infauna as a result of oil adhering to sediment. Mesocosm experiments using long-term, low-level concentrations of No. 2 fuel oil indicate acute toxicity to meiofauna because of direct oil contact and sublethal effects from sedimented oil and byproducts of the decomposition of the sedimented oil (Frithsen et al., 1985). Long-term exposure to low levels of fuel oil was shown to affect recruitment success; meiofaunal population recovery took between 2 and 7 months (Frithsen et al., 1985). Oil entrained within sediments at the seafloor could create a layer toxic to infaunal species. This layer will persist through burial unless it is sufficiently degraded over time. Continued deposition of pelagic material could bury the layer, but it will remain intact over some timeframe as a potentially toxic or lethal horizon.

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 be come 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.

If dispersants are used at the sea surface, oil may mix into the water column, and if they are applied subsea, they can travel with currents through the water and may settle on the seafloor. If near the source, the dispersed oil could be concentrated enough to harm the benthic 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 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., 1981). Dispersant usage also reduces the oil’s ability to stick to particles in the water column, minimizing sedimented oil traveling to the seafloor (McAuliffe et al., 1981). There is very little information on the behavior of subsea dispersants.

Dispersed oil reaching the benthic communities 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 depth based on experiments conducted with benthic and pelagic test 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 DWH event, 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 sea floor was also reported by OSAT (2010) where no dispersants were detected in sediment on the Gulf floor following the DWH event.

Oil-degrading bacteria may ameliorate the effects of oil in the water column and benthic environments. Oil-degrading bacteria was detected in the subsea oil plume following the DWH event, and although this bacteria had reduced some oxygen in the water column when it degraded the oil, the decrease in oxygen was small compared with the surrounding water column (Hazen at al., 2010). Field measurements collected from the subsea plume indicated that these dissolved oxygen levels never approached hypoxic (<1.4 mL oxygen/L water) levels (Joint Analysis Group, 2010b). The dissolved oxygen in the water column did not appear to be decreasing over time, indicating that the oil was mixing with the surrounding oxygen-rich water (Joint Analysis Group, 2010b). The dissolved reduced oxygen levels produced by the bacteria never approached the low dissolved oxygen levels that occur during a yearly hypoxic event on the continental shelf of the northern Gulf of Mexico for prolonged periods during the spring through late summer (Rabalais et al., 2002). This hypoxic event results in lower dissolved oxygen levels than what were measured in the water column and bottom waters as a result of the DWH event (Joint Analysis Group, 2010a and 2010b; Haddad and Murawski, 2010).

Once the petroleum source has been reduced, the bacteria may die and sink to the seafloor. If enough dead bacteria accumulate in an area, the degradation of these bacteria by other bacteria may result in a locally decreased oxygen levels that may impact the nearby benthic organisms.

Hard-Bottom Benthic Communities

Sensitive reef communities flourish wherever hard bottoms occur in the Gulf of Mexico. Several categories of hard bottom communities are protected by BOEM. The eastern Gulf of Mexico contains scattered, low-relief live bottoms including areas of flat limestone shelf rock. Potentially sensitive biological features are 8 ft (2 m) or more above the seafloor. The Pinnacle Trend area includes low- and high-relief features and is 60-120 m (200-400 ft) below the sea surface, and topographic features are high relief and generally 15 m (49 ft) or more below the sea surface. Their depth below the sea surface protects all of these habitats from a surface oil spill.

Although hard-bottom benthic communities are initially buffered from surface oil slicks by their depth below the sea surface, surface oil may be brought to depth through physical processes. Rough seas may mix the oil into subsurface water layers, where it may impact sessile biota. The total time during which seas are rough would help affect the amount of oil from a surface slick that would be mixed into the water column. Measurable amounts of oil have been documented down to a 10-m (33-ft) depth, although modeling exercises have indicated such oil may reach a depth of 20 m (66 ft). At this depth, however, the 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).

The presence of a subsurface oil plume may affect hard-bottom communities. A majority of the oil released is expected to rise rapidly to the sea surface. However, upward movement of the oil may be reduced if methane in the oil is dissolved under high pressures, and oil droplets may become entrained deep in the water column (Adcroft et al., 2010). Subsurface plumes generated by high-pressure dissolution of oil may come in contact with hard-bottom features. 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 when it contacts the seafloor (Hazen et al., 2010). However, a sustained spill may result in elevated exposure concentrations to hard-bottom features if the plume reaches them. The longer the spill takes to stop, the longer the exposure time and concentration may be.

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. Experiments indicated that normal feeding activity of *Porites porites* and *Madracis asperula* were reduced when exposed to 50 ppm oil (Lewis, 1971). Reefs of *Siderastrea sidereal* 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).

If dispersants are used on the seafloor or at the surface, oil may mix into the water column, and if they are applied subsea, they can travel with currents through the water, and they may contact or settle on hard bottoms. 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 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., 1981). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing sedimented oil traveling to the seafloor (McAuliffe et al., 1981). There is very little information on the behavior of subsea dispersants.

Dispersed oil reaching the benthic hard-bottom communities in the Gulf of Mexico would be expected to be at very low concentrations (less than 1 ppm) (McAuliffe et al., 1981). Such concentrations would not be life threatening to larval or adult stages at depth 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 are some impacts that may occur to 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.

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).

The BOEM's policy prevents wells from being placed immediately adjacent to sensitive communities. In the event of a seafloor blowout, however, some oil could be carried to hard 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 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 dispersed. 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).

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 hard-bottom features as a result of setting anchors. 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 hard-bottom community to prevent extruded drilling muds from smothering benthic communities. However, if drilling muds were to travel far enough or high enough in the water column to contact a hard-bottom 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). As discussed earlier, as the drilling fluids biodegrade, an anoxic zone surrounding the activity may occur. Recolonization would occur from the surrounding community once the area has enough oxygen to support new growth, which may take 3-5 years (Neff et al., 2000).

3.2.2.7. Deepwater Benthic Communities

It is not likely that deepwater benthic communities would be impacted by a spill from a shallow-water blowout. However, a spill resulting from a catastrophic blowout in deep water has the potential to impact offshore benthic communities because of the blowout's proximity to these habitats and the use of subsea dispersants.

Much of the oil is expected to be treated with dispersants at the sea surface and possibly subsea at the source in the event of a deepwater blowout. The dispersed oil is mixed with the water, and its movement is then dictated by local currents and the physical, chemical, and biological degradation pathways. The oil would become more dispersed, less concentrated, and more biodegraded the longer it remains suspended in the water column. Depending on how long it remained suspended in the water column, it may be thoroughly degraded by biological action before contact with the seafloor and its sensitive resources occurs (Hazen et al., 2010; Valentine et al., 2010). Biodegradation rates in colder, deepwater environments are not well understood at this time. Oil may reach the seafloor in the following ways: as microbes begin to consume the oil particles; when the dispersed oil particles may flocculate (flocculation is suspended particles collecting into larger suspended flakes), thus increasing the density of the particles such that they are no longer in isostatic balance with the surrounding water and, thus, sink to the seafloor; when larger plankton consume the bacteria-rich oil particles and their fecal pellets are excreted and distributed over the seafloor; when water currents carry a plume to contact the seafloor directly; or most likely, where the dispersed oil to adhere to other particles and sink to the seafloor. This last scenario would result in a wide distribution of small amounts of oil. This oil could be in the process of biodegradation from bacterial action that would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment. Biodegradation processes, both on the bottom and in the water column, would be expected to cause at least some reduction of normal ambient dissolved oxygen levels; however, this has yet to be observed at a level that would be detrimental to animal respiration (Hazen et al., 2010).

Deepwater Soft-Bottom Benthic Communities

Soft bottoms are the overwhelming majority of the deep-sea environment. Large amounts of oil would only affect these deep environments if dispersants are used. As described above, the toxic effects of dispersed oil would continue to decrease as the concentration of oil is reduced via dispersion, localized mixing, and biodegradation. As with shelf habitats, the only soft bottom that is expected to suffer significant effects would be soft bottoms in the immediate vicinity of a seafloor blowout in which some oil is mixed into the sediment. 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—a matter of days for bacteria and probably less than 1 year for most macrofauna and megafauna species. This could take longer for areas affected by direct oil contact in higher concentrations.

Deepwater Coral Benthic Communities

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. Response of deepwater coral to oil exposure from a catastrophic spill would vary, depending on the level of exposure. 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 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 discernable 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. However, because of the scarcity of deepwater hard bottoms and the comparatively low surface area, it is unlikely that a sensitive habitat would be located near a seafloor blowout, or if near, that concentrated oil would contact the site.

Deepwater Chemosynthetic Benthic Communities

Chemosynthetic communities in the GOM are adapted to cold seep habitats where oil, methane, and hydrogen sulfide seep up through the seafloor. If contacted by low quantities of well-dispersed oil undergoing biodegradation, chemosynthetic communities may experience little negative effect. Exposure may be similar to normal conditions for these communities and may be within the normal variation of habitat conditions. However, oil contact could cause some fluctuation in organism health, resulting in slower growth or delayed spawning. Since these organisms grow slowly, sublethal effects could eliminate a year or more of normal growth. 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. Other invertebrates associated with chemosynthetic communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure. Recolonization of severely damaged or destroyed communities could take years or decades.

3.2.3. Socioeconomic Resources

3.2.3.1. Offshore Archaeological Resources

Due 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, the use of 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 DWH event. 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 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.

3.2.3.2. Commercial Fishing

In 2008, the Gulf of Mexico provided over 33 percent of the commercial fishery landings in the continental U.S. (excluding Alaska), with nearly 1.3 billion pounds valued at nearly $660 million (USDOC, NMFS, 2010b).

Even though sensory and chemical testing may show no detectable oil or dispersant odors or flavors and the results could be well below the levels of concern, NOAA Fisheries would be expected to close large portions of the Gulf of Mexico during a high-volume spill as a precautionary measure to ensure public safety and to assure consumer confidence in Gulf seafood (USDOC, NOAA, NOAA Fisheries Service, 2010a). Up to 30-40 percent of the Gulf of Mexico Exclusive Economic Zone (EEZ) could be closed to commercial fishing as the spill continues and expands (USDOC, NOAA, NOAA Fisheries Service, 2010b). This area could represent 50-75 percent of the Gulf seafood production (Flynn, 2010). The size of the closure area may peak about 50 days into the spill and 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 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.

3.2.3.3. Recreational Fishing

Up to 30-40 percent of the Gulf of Mexico EEZ could be closed to recreational fishing as the spill continues and expands (USDOC, NOAA, NOAA Fisheries, 2010b). The size of the closure area could peak about 50 days into the spill and continue for 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 recreational fishing.

In 2008, over 24 million recreational fishing trips were taken; these trips generated about $12 billion in sales, over $6 billion in value-added impacts, and over 100,000 jobs (USDOC, NOAA, NMFS, 2010b). About 33 percent of the total Gulf catch came on trips that fished primarily in Federal and State waters (Pritchard, 2009). Recreational fishing is focused in the summer months. During this time, scheduled tournaments would be hard to reschedule. If the spill affected that time of year, normal direct income and indirect income to the communities that host these tournaments would be lost for that year. If a catastrophic spill occurs in the summer, a substantial number of recreational fishing trips would not occur and the economic benefits they generate would be lost for that year.

3.2.3.4. Tourism and Recreational Resources

While the spill is still offshore, there could be some ocean-dependent recreation that is affected (e.g., fishing, diving), 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. For example, studies during the DWH oil spill show that perceptions can influence recreational activity, even if an oil spill has not yet damaged physical resources in an area (The Knowland Group, 2010; Market Dynamics Research Group, 2010). However, the majority of the impacts of a catastrophic spill would occur once the spill has contacted shore, as discussed in Section 4.2.3.4.

3.2.3.5. Employment and Demographics

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 6-month suspension, as a result of the DWH event, 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). Most of these jobs were not permanently lost as a result of the suspension and returned following the resumption of deepwater drilling in the Gulf of Mexico. These estimates are lower than earlier estimates of 15,000-60,000 rig and associated service jobs being at risk (Hargreaves, 2010; Louisiana Mid-Continent Oil and Gas Association, 2010; Zeller, 2010; Jindal, 2010).

Whatever the number, much of the employment loss would be concentrated in coastal oil-service parishes in Louisiana (St. Mary, Terrebonne, Lafourche, Iberia, and Plaquemines) and counties/parishes where drilling-related employment is most concentrated (Harris County, Texas, in which Houston is located, and Lafayette Parish, Louisiana) (Nolan and Good, 2010; U.S. Dept. of Labor, BLS, 2010). There would be additional economic impacts to commercial and recreational fishing, as discussed in Sections 3.2.3.2 and 3.2.3.3. This impact is also expected to be more heavily concentrated in smaller businesses than in the larger companies (USDOC, Economics and Statistics Administration, 2010).

Demographic impacts are unlikely from temporary job losses.

3.2.3.6. Land Use and Coastal Infrastructure

Impacts to tourism and recreational resources are addressed in Section 3.2.3.4. Possible fisheries closures are addressed in Sections 3.2.3.2 and 3.2.3.3. While still offshore, a catastrophic oil spill would not impact other land use or coastal infrastructure.

3.2.3.7. Environmental Justice

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 (see Sections 3.2.3.2 and 3.2.3.3). 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 are home to families with some of the few black-owned oyster leases, which because of freshwater diversion projects for coastal restoration have already been threatened (Mock, 2010).

The Gulf 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 Coast populations of particular concern. An estimated 20,000 Vietnamese fishermen and shrimpers live along the Gulf 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 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 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 would disproportionately affect such minority groups as the Vietnamese, Native Americans, African Americans, and Islaños (Hemmerling and Colten, 2003).

4. ONSHORE CONTACT (PHASE 3)

4.1. IMPACT-PRODUCING FACTORS AND SCENARIO

4.1.1. Duration

The duration of the 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 the well's water depth. 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. While it is assumed that the majority of spilled oil would dissipate offshore within 30 days of stopping the flow, some oil may remain in coastal areas until cleaned, as seen in Louisiana following the DWH event (State of Louisiana, 2010a-d).

4.1.1.1. 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 (1-3 months) and the oil dissipates offshore (1 month). Therefore, it is estimated that shoreline oiling would likely occur for 1-4 months following a catastrophic blowout.

4.1.1.2. Deep Water

As discussed in Section 3.1.1, intervention is more difficult and would take longer in deeper water. In general, most of the deep water in the Gulf of Mexico is located far from shore and, therefore, it is assumed that oil would reach shore within 2-4 weeks. While most deep water is located far from shore, some areas of deep water are located relatively nearshore so that oil could reach shore earlier.

The length of shoreline oiled would continue to increase until the well is killed or capped (3-4 months) and the oil dissipates offshore (1 month). Therefore, shoreline oiling could occur for 3 to more than 4 months following a catastrophic blowout.

4.1.2. Volume of Oil

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 biodegradation offshore or inshore contact.

In the case of the DWH event, 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, 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 154, Appendix C, Table 2). Using the USCG assumptions, a catastrophic spill could still result in a large amount of oil reaching shore.

4.1.3. 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. As seen with the DWH 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.

Dependent upon winds and currents throughout the spill event, already impacted areas could be reoiled.

4.1.3.1. 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 Section 3.1, the site would 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.

4.1.3.2. Deep Water

While a catastrophic spill from a deepwater blowout is expected to have a much greater volume than a shallow-water blowout (see Section 3.1), the site would be farther from shore, allowing more time for oil to be weathered, dispersed, and recovered. This could result in a 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).

4.1.4. Severe Weather

The Atlantic hurricane season runs from June 1st through November 30th, peaking 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, 2010a). 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.

4.1.5. Onshore Cleanup Activities

As described in Section 3.1, a large-scale response effort would be expected for a catastrophic blowout. The number of vessels and responders would increase exponentially as the spill continued. In addition to the response described in Section 3.1.6, the following response is also estimated to occur once the spill contacts the shore.

An exponential increase in the length of shoreline impacted would likely overwhelm response efforts.

4.1.5.1. Shallow Water

- There would be 5-10 staging areas established.
- Weathering permitting, about 200-300 skimmers could be deployed near shore to protect coastlines.

4.1.5.2. 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 DWH event, a few hundred coastal skimmers could still be in operation a few months after the well is capped or killed (State of Louisiana, 2010e).

4.2. MOST LIKELY AND MOST SIGNIFICANT IMPACTS

The most recent EIS's prepared by this Agency for oil and gas lease sales in the Gulf of Mexico identify in detail the potential impacts from reasonably foreseeable oil spills (USDOI MMS, 2007 and 2008). The most likely and significant onshore impacts caused by a catastrophic spill are described below.

4.2.1. Physical Resources

4.2.1.1. Air Quality

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 permissible exposure levels (U.S. Department of Labor, OSHA, 2010b). During the DWH oil spill, 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 DWH event, 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 one sample where benzene exceeded the OSHA Occupational Permissible Exposure Limits, and six additional validated constituents that were in excess of the ACGIH threshold limit value. All other sample concentrations were below the more stringent ACGIH threshold limit values (U.S. Department of Labor, OSHA, 2010a). All measured concentrations of toluene, ethylbenzene, and xylene were well within the OSHA permissible exposure levels and ACGIH threshold limit values.

4.2.1.2. 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 commercially significant 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. In the Gulf of Mexico, water quality prior to the DWH event was rated as fair while sediment quality was rated as poor (USEPA, 2008). In addition, the coastal habit 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 between 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, 2010c). 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. For instance, microbial metabolism of crude oil results in the dispersion of oil (Bartha and Atlas, 1983). 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 more available to microorganisms, which temporarily increases the toxicity (Bartha and Atlas, 1983). 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 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, which carry nutrients to the surface waters. The hypoxic conditions continue until local wind-driven circulation mixes the water again. The 2010 hypoxic zone could not be linked to the DWH event in either a positive or a negative manner (Louisiana Universities Marine Consortium (LUMCON), 2010). Nutrients from the Mississippi River nourished phytoplankton and attributed to the formation of the hypoxic zone.

4.2.2. Biological Resources

Recent EIS's prepared by this Agency for oil and gas lease sales in the Gulf of Mexico detail the potential localized impacts to individuals from reasonably foreseeable oil spills. However, a catastrophic event, such as a high-volume, extended-duration spill resulting from a blowout, has the potential to cause population level impacts, as described below.

Dozens of Federal and State-listed threatened and endangered species, including marine mammals, sea turtles, fish, and birds, could continue to be impacted during Phase 3 of a catastrophic oil spill as oil and response activities persist. Additional species could be impacted in extreme conditions (i.e., oil is pushed onto beaches or into rivers or marshes because of a hurricane) (USDOI, FWS, 2010a and 2010b).

4.2.2.1. Coastal and Marine Birds

Gulf coastal habitats are essential to the annual cycles of many species of breeding, wintering, and migrating waterfowl, wading birds, shorebirds, and songbirds. For example, the northern Gulf Coast supports a disproportionately high number of beach-nesting bird species (USDOI, FWS, 2010c). Once oil contacts shore, a few dozen to over a hundred birds could be impacted daily by oiling and/or collection. By extrapolating the number of birds impacted as a result of the DWH event, a spill lasting 120 days could result in direct mortality of over 7,000 birds (USDOI, FWS, 2010d). This number does not reflect total realized mortality but rather only the actual number of birds recovered as of October 2010. This number represents a small fraction of total bird mortality because of carcasses sinking, being scavenged, drifting outside the search zone, or simply going undetected because of wind, current, weather, and habitat factors (Ford et al., 1987; Piatt et al., 1990; Fowler and Flint, 1997; Flint et al., 1999; Wiese and Robertson, 2004; Byrd et al., 2009). In an early review of oil-related mortality for seabirds, Dunnet et al. (1982) provided an estimate of 10 percent, and 60 percent of the dead birds may be recovered under typical field conditions. Piatt and Ford (1996, Table 1) summarized recovery rates from 17 carcass-drift experiments, indicating a range of 0-59 percent of carcasses being recovered. Using data from the *Exxon Valdez* oil spill, Piatt and Ford (1996) estimated recovery rates from joint probability and Monte Carlos simulations of only 8.0 percent and 6.9 percent, respectively.

The timing and location of the spill are the two primary factors for determining the severity of impacts on birds. The worst impacts to oiled birds or to those birds that have ingested oil with their prey would be if the oil spill occurs during the nesting season. An oil spill during nesting season could result in the loss of entire colonies of breeding birds on barrier islands surrounded by oil, along with the potential loss of all eggs and nestlings. Losses of shorebirds could occur through direct oiling of beaches on which nests are located, by oil covering the feeding sites near the nesting locations, or by the deaths of oiled parents, leaving eggs or hatchlings unprotected and unfed.

Endangered and Threatened Birds

Four species listed as endangered or threatened by the U.S. Fish and Wildlife Service that could be affected by a catastrophic oil spill are the piping plover (*Charadrius melodus*), Mississippi sandhill crane (*Grus Canadensis pulla*), whooping crane (*Grus americana)*, and wood stork (*Mycteria americana)*. The Midwest Population of piping plovers, which nests along the Great Lakes, is listed as endangered while the Atlantic Coast and Northern Great Plains Populations are listed as threatened. The critical habitat for the plover is found within the wintering area, which includes areas along the Gulf Coast from Texas to

Florida (LeDee et al., 2008, Figure 1; Haig et al., 2005, Figure 1), where they feed on aquatic insects, invertebrates, and small crustaceans along the advancing and retreating water line of the beaches. Unknown numbers of piping plovers could therefore become oiled or have their feeding areas oiled if a spill occurred during the time of year, roughly October through March, when plovers are present (Haig et al., 2005, Figure 1 and Table 2).

The cranes and wood stork are tall wading birds. The whooping crane is found in Texas, Louisiana, and Florida, and the wood stork is found in Alabama, Florida, Georgia, and South Carolina. The only self-sustaining wild population nests in the Northwest Territories and adjacent areas of Alberta, Canada, primarily within the boundaries of Wood Buffalo National Park. These birds winter in coastal marshes and estuarine habitats along the Gulf Coast in the Aransas National Wildlife Refuge in Texas, and they represent the majority of the world's population of free-ranging whooping cranes. A total of 10 whooping cranes were reintroduced to Louisiana in the White Lake Conservation Area (about 17 mi [27 km] from the Gulf Coast) during the winter of 2011 as a nonessential experimental population. The Mississippi sandhill crane population was listed as endangered on June 4, 1973, under the Endangered Species Act. This nonmigratory species is found only in Mississippi, but historically it may have ranged in Louisiana, Mississippi, Alabama, Georgia, and Florida (USDOI, FWS, 1973, 1991; Tacha et al., 1992).

Both the whooping and sandhill crane species use marsh habitats and eat small fish, frogs, mollusks, snails, insects, crustaceans, and aquatic invertebrates. Thus, they could both become oiled directly if oil reaches the marshes. They could also ingest oil along with their primary prey items, and their prey could be substantially reduced because of oil, resulting in a decline in health and reproduction in both species of wading birds. However, both species of cranes are located somewhat away from the shoreline of the open Gulf of Mexico and would not be likely to be affected by a catastrophic spill unless it worked its way into estuarine marshes.

The U.S. breeding population of wood storks was listed as endangered for Alabama, Florida, Georgia, and South Carolina under the Endangered Species Act on February 24, 1984, because of the overall impact of human activities on breeding colonies. Although it likely has a low probability of oiling from a catastrophic spill due to its selection of more inland freshwater marshes, it may forage in coastal, brackish, or saltwater marshes, thus increasing its probability of oiling in the case where spilled oil is pushed into the rivers and marshes because of hurricanes, tropical storms, and the associated storm surge.

4.2.2.2. Fish, Fisheries, and Essential Fish Habitat

The life history of estuarine-dependent species involves spawning on the continental shelf, 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 essential fish habitat for fish and 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. 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). Therefore, if a catastrophic blowout occurs in the spring and summer seasons, it could cause greater harm to fish populations and not just individual fish.

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, the year's oyster production would be lost because of exposure to freshwater and/or oil. Depending on the severity, oyster beds could take 2-5 years to recover (Burdeau, 2010).

4.2.2.3. Marine Mammals

Section 3.2.2 discusses the most likely and most significant impacts to the offshore marine mammal community. A high-volume oil spill lasting 120 days could directly impact over 20 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. During warmer months, manatees are common along the Gulf Coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida, and they are less common farther westward. In winter, the Gulf of Mexico subpopulations move southward to warmer waters. The winter range is restricted to waters at the southern tip of Florida and to waters near localized warm-water sources, such as power plant outfalls and natural springs in west-central Florida. 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.

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. The 2009 Stock Assessment Report (USDOI, FWS, 2009) for the Florida stock of West Indian manatees estimates that there is a minimum population estimate of 3,802 individuals based on a single synoptic survey of warm-water refuges in January 2009. The manatee's potential biological removal is the maximum number of animals, not including natural mortalities, that may be removed from the population or stock while allowing that stock to reach or maintain its optimum sustainable population and is approximately 12 individuals. 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.

Bottlenose dolphins were the most affected species of marine mammals from the DWH event. There were 171 marine mammals collected as of April 20, 2010 (the majority of which were deceased). This includes 155 bottlenose dolphins, 2 *Kogia* spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NOAA, NOAA Fisheries, 2011). 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 DWH event. 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.

4.2.2.4. Sea Turtles

Out of the five species of sea turtle that occur in the Gulf of Mexico, only three nest in this area. The largest nesting location for the Kemp's ridley sea turtle is in Rancho Nuevo, Mexico, but they also nest in Texas. Loggerhead sea turtles nest in all states around the Gulf of Mexico. There are also records of nesting colonies of hawksbill sea turtles in the Yucatan Peninsula of Mexico (Plotkin, 1995; OBIS-SEAMAP, 2009). Kemp's ridley, loggerhead, and hawksbill sea turtles are therefore most likely to be affected by a catastrophic oil spill when there is onshore 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, 2010f). 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, 2010e). 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.

4.2.2.5. Terrestrial Mammals and Reptiles

Beach Mice

Seven subspecies of the field mouse, collectively known as beach mice, live along the Gulf Coast. Five subspecies of beach mice (Alabama, Perdido Key, Choctawhatchee, St. Andrew, and Anastasia Island) are listed as State and federally endangered; the southeastern beach mouse is listed as federally threatened; and the Santa Rosa beach mouse is a Federal species of concern. Beach mice are restricted to the coastal barrier sand dunes along the Gulf Coast 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 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, and Perdido Key beach mice are already designated as protected species under the Endangered Species Act because of the loss of coastal habitat (USDOI, MMS, 2007). The species' coastal habitat is designated as their critical habitat. For example, the endangered Alabama beach mouse's (*Peromyscus polionotus ammobates*) habitat is 1,211 acres (490 hectares) of frontal dunes covering just 10 mi (16 km) of shoreline designated as critical habitat (USDOI, FWS, 2007). Critical habitat is the specific geographic areas that are essential for the conservation of a threatened or endangered species. With the potential oiling of over 1,000 mi (1,609 km) of shoreline, the entire critical habitat for a subspecies of beach mice could be completely oiled. Thus, destruction of the remaining habitat because of a catastrophic spill and cleanup activities would increase the threat of extinction of several subspecies of beach mice.

Diamondback Terrapin

The Texas diamondback terrapin (*Malaclemys terrapin littoralis*) and the Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) are two subspecies of terrapin that occur in the Gulf of Mexico, and they are Federal species of concern. The former's range runs from Louisiana through Texas, while the latter's includes Louisiana, Mississippi, Alabama, and Florida (USDOI, FWS, 2010f). 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). 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 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. Terrapin nests can also be disturbed or destroyed by cleanup efforts. The range of the possible chronic effects from oil and dispersants contact including lethal or sublethal oil-related injuries 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.

4.2.2.6. Coastal Habitats

A spill from a catastrophic blowout lasting up to 120 days could impact over 1,000 mi (1,609 km) of shoreline. Shoreline oiling would vary between heavy, moderate, light, and occasional tarballs. Due to the length of shoreline that could potentially be oiled and the sensitivity of the Gulf Coast, a high-volume, extended-duration spill could cause extensive habitat degradation. Loss of vegetation could lead to erosion and permanent landloss.

In some previous spills reviewed, a strong storm removed the majority of oil from shore. However, storm surges may carry oil into the coastline and inland as far as the surge reaches. In addition, four significant hurricanes (Katrina, Rita, Gustav, and Ike) have made landfall along the Texas/Louisiana coast in the last 6 years, greatly degrading the coastal beaches, marshes, and barrier islands, making them more susceptible to a catastrophic spill.

Coastal Barrier Beaches and Associated Dunes

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 secondarily to 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.

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 would have little deleterious effects on the existing vegetation or on the recolonization of the oiled sands by plants (Webb, 1988). 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. In areas designated as natural wilderness areas (e.g., Breton National Wildlife National 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 will be used in these areas and only if heavy oiling has occurred. Thus, these areas may not be treated as thoroughly as other shorelines.

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 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, would reduce the impact severity at a landfall site because they would accelerate the processes of oil-slick dispersal, spill spreading, and oil weathering.

Due to the distance of beaches from deepwater blowout and the combination of weathering and dispersant treatment of the oil offshore, the toxicity 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 is 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 are in close proximity to these islands, recovery time of the barrier islands could be greatly extended because of the magnitude of vessels responding to a catastrophic spill.

Wetlands

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. A spill from a catastrophic blowout could oil a few to several hundreds of acres of wetlands depending on the depth of inland penetration (Burdeau and Collins, 2010). This would vary from moderate to heavy oiling.

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 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 the wetlands behind them. Boom deployment must also include plans for monitoring and maintaining the protective booms 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.

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 good chance of survival, even though aboveground die-off of marsh vegetation may occur (Lin et al., 2002). However, if reoiling 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. Longer term damage may result from continued reoiling than from a temporally continuous oiling (Lin et al, 2002; Lin and Mendelssohn, 2009). 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. The utilization of nearshore booming protection for beaches and wetlands, in combination with offshore skimming, burning, and dispersal treatments for the oil near the spill site, would result in capture and detoxification of the majority of oil reaching shore. Therefore, a spill from a shallow-water blowout is more likely to contribute to wetland damage.

The activity of oil cleanup can result in additional impacts on wetlands if not done properly. During the DWH event, aggressive onshore and marsh cleanup methods were not utilized.

Submerged Vegetation

Approximately 500,000 hectares (1.25 million acres) 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 (Beck et al., 2006; Carlson and

Madley, 2006). Submerged vegetation distribution depends on an interrelationship between a number of environmental factors that include temperature, water depth, turbidity, salinity, turbulence, and substrate suitability (Sheridan and Minello, 2003). 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 habitat for immature shrimp, black drum, spotted sea trout, juvenile southern flounder, and several other fish species and provide a food source for species of wintering waterfowl (Castellanos and Rozas, 2001; Short et al., 2001; Caldwell, 2003). These areas would have considerable impact from various cleanup efforts, such as increased vessel traffic. Although many of the beds are protected by extensive barrier islands, severe storms can cause inundation and overwashing of these islands, resulting in oiling of the seagrass beds if the storm occurred during an oil spill. In addition, boom anchors could damage seagrass beds (USDOC, NOAA, 2010f). It is assumed that there would be a decrease in submerged vegetation and a negative impact on the bed communities in a highly affected area. If bays and estuaries accrue oil, there is an assumption that there would be a decrease in seagrass cover and negative community impacts. Depending on the species and environmental factors, seagrasses may exhibit minimal impacts from a spill; however, communities within the beds could accrue greater negative outcomes (Jackson et al., 1989; Taylor et al., 2006). Community effects could range from direct mortality because of smothering or indirect mortality from loss of food sources and loss of habitat because of a decrease in ecological performance of the entire system (Zieman et al., 1984).

4.2.3. Socioeconomic Resources

4.2.3.1. 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. Sites on barrier islands could suffer the heaviest impact (McGimsey, personal communication, 2010). 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. 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, personal 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, personal communication, 2011).

4.2.3.2. Commercial Fishing

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 transits.

4.2.3.3. Recreational Fishing

In addition to closures in Federal waters, portions to of individual State waters would also be closed to recreational fishing. More than 67 percent of the total Gulf catch came on trips that fished primarily in inland waters (Pritchard, 2009). In 2008, over 24 million recreational fishing trips were taken, which generated about $12 billion in sales, over $6 billion in value added impacts, and over 100,000 jobs (USDOC, NOAA, NMFS, 2010b). The majority of recreational fishing occurs in the summer months. During this time, scheduled fishing tournaments are held and would be hard to reschedule. If the spill affected the summer months, normal direct income and indirect income to the communities that host these tournaments would be lost for that year. If a catastrophic spill occurs in the summer, the majority of recreational fishing trips would not occur and economic benefits they generate would be lost for that year.

4.2.3.4. Tourism and Recreational Resources

Tourism and recreation are integral components of the economy of the Gulf of Mexico. Visitors to Texas, Louisiana, Mississippi, Alabama, and Florida spent approximately $145 billion in 2008 (U.S. Travel Association (2010). This spending helped to support approximately 2.4 million jobs in recreation-based industries statewide (U.S. Dept. of Labor, 2010a). Roughly 600,000 of these jobs are in counties and parishes that are directly along the coast, making them particularly vulnerable to a catastrophic event and the likely associated decrease in tourism. Recreation jobs account for 14.8 percent of Gulf Coast employment, greater than the national average of 12.4 percent (QCEW Fact Sheet). The coastal counties and parishes that have the highest concentration of recreation workers (over 10,000 workers) in each state are as follows: Cameron, Nueces, and Galveston Counties (Texas); Jefferson and Orleans Parishes (Louisiana); Harrison County (Mississippi); Mobile and Baldwin Counties (Alabama); and Escambia, Okaloosa, Bay, Pasco, Pinellas, Hillsborough, Manatee, Sarasota, Lee, Collier, Broward, and Miami-Dade Counties (Florida). Gulf Coast recreational employment is reasonably cyclical, with the peak months during the past few years occurring between March and June (U.S. Dept. of Labor, 2010b).

A catastrophic spill has the potential to significantly impact the Gulf Coast recreation and tourism industries. The water-dependent and beach-dependent components of these industries would be particularly vulnerable. This is particularly true for some of the nature parks and island resources directly along the coast, such as Padre Island National Seashore (Texas), Dauphin Island (Alabama), and the Gulf Islands National Seashore (Mississippi/Florida). Kaplan and Whitman (unpublished) attempt to isolate the economic significance of the recreational resources in the Gulf of Mexico that are particularly relevant to OCS oil and gas activities. They found roughly 60,000 jobs that were dependent on these activities in 2005, although there is uncertainty with this estimate, because of measurement issues and events that have occurred since their data collection period (most notably Hurricane Katrina).

In analyzing the potential impacts of a catastrophic spill, one must also consider the range of activities that depend on the base resources that may be affected. For example, the restaurant and lodging industries are particularly important to the Gulf economy. They are also sensitive to general tourism trends in any particular area. However, the economic impacts on these sectors from a spill may be partially offset because of an influx of cleanup and relief workers. Finally, one should consider the economic context in which a catastrophic event occurs. The DWH event occurred in the context of an economy that was only beginning to recover from a very deep recession. In difficult economic times, recreation workers may be more prone to being laid off in response to a catastrophic event. Workers may also find it more difficult to transition between jobs, which can increase the severity of the economic effects. In a recession, tourism also may be more sensitive both to actual damage and to perceptions of economic problems within a region.

4.2.3.5. Employment and Demographics

By the end of a catastrophic spill, up to 50,000 personnel 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, investing less money in the economy (Aversa, 2010). Permanent demographic impacts are unlikely from these temporary jobs.

There would be additional economic impacts to tourism and both recreational and commercial fishing, as discussed in Sections 4.2.3.2 through 4.2.3.4 above.

4.2.3.6. Land Use and Coastal Infrastructure

In the event of a catastrophic spill, impacts on land use and infrastructure would be temporary and variable in nature. These impacts include land use in staging areas, waste disposal locations and capacities, and potential delays because of vessel decontamination stations near ports, as described below.

Up to 20 staging areas and as many as 50,000 responders would likely result in increased 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 a drilling suspension was enacted, like the one related to the DWH event, conflicting demands on infrastructure facilities would likely fail to materialize (Dismukes, personal communication, 2010a).

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 are disposed of in onshore landfills. The USEPA, in consultation with the U.S. Coast Guard, 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, 2010d and 2010e).

For navigation and port use, there is also 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, most cleanup activities would be complete within a year of the event, so impacts would be expected to be limited in duration (Dismukes, personal communication, 2010b).

4.2.3.7. Environmental Justice

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 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 (see 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 recent hurricane events.

State fishery closures because of a catastrophic oil spill would disproportionately affect minority and low-income groups. Shoreline impacts would generate additional subsistence-related effects. Therefore, these minority groups would be disproportionately affected if these coastal areas were impacted by a catastrophic spill and the resulting response.

5. POST-SPILL, LONG-TERM RECOVERY (PHASE 4)

5.1. IMPACT-PRODUCING FACTORS AND SCENARIO

During the final phase 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 within 30 days of stopping the flow (Lubchenco et al., 2010), 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, 2010g).

5.2. MOST LIKELY AND MOST SIGNIFICANT IMPACTS

At this point in the scenario, the spill has been stopped and long-term recovery begins. There is a great deal of uncertainty regarding the long-term impacts of a catastrophic spill in the Gulf of Mexico. The most likely and most significant impacts, as described below, will likely relate to the continued exposure of organisms to the spilled oil, oil components, and dispersants remaining in the air, water, and sediments, as well as the effects of continued cleanup efforts.

A catastrophic spill can have long-term impacts on Gulf of Mexico ecosystems. An ecosystem is a geographically specified system of organisms, including humans, their environment, and the processes that control their dynamics. Ecosystems involve complex connections between organisms, their environment, and the processes that drive the system (USDOC, NOAA, 2010g). In some cases, marine ecosystems may take decades to fully recover or may recover to alternative states (Ragen, 2010).

5.2.1. Physical Resources

5.2.1.1. Air Quality

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, as discussed in Sections 2.2.1.1, 3.2.1.1, and 4.2.1.1, adverse effects that may occur from the exposure of humans and wildlife to air pollutants could have long-term consequences.

5.2.1.2. Coastal and Offshore Water Quality

The leading source of contaminants that impairs coastal water quality in the Gulf of Mexico is urban runoff. Urban runoff 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 103 percent population growth since 1970 (USDOC, NOAA, NOS, 2008). 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, p. 237) estimated that, on average, approximately 26,324 barrels 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 barrels/year (NRC, 2003, Table I-9, p. 242) into the waters of the Gulf. Hydrocarbons also enter the Gulf of Mexico through the result of natural seeps in the Gulf of Mexico at a rate of approximately 980,392 barrels per year (a range of approximately 560,224-1,400,560 barrels/year) (NRC, 2003, p. 191). Produced water (formation water) is, by volume, the largest waste stream from the oil and gas industry that enters Gulf waters. The NRC has estimated the quantity of oil in produced water entering the Gulf per year to be 473,000 bbl (NRC, 2003, p. 200, Table D-8).[2] These sources total about 5.5 million barrels of oil per year that routinely enters Gulf of Mexico waters. In comparison, a catastrophic spill of 30,000-60,000 barrels per day for 90-120 days would spill a total of 2.7-7.2 million barrels 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 spill will be much more concentrated in some locations than the large number of other activities that release oil into the Gulf of Mexico. Section 3.1.4 discusses the properties and persistence of oil in the environment.

2 These numbers were generated from converting the units reported in the noted reference and do not imply any level of significance.

5.2.2. Biological Resources

As described below, long-term consequences on biological resources can include impaired reproduction, which can potentially impact population levels. 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. Oil in these systems has the potential to have long-term impacts on fish and wildlife populations.

Some animals may survive initial exposure to spilled oil but may accumulate high levels of contaminants in their bodies that can be passed on to predators, in a process known as bioaccumulation (USDOI, FWS, 2010g).

5.2.2.1. Coastal and Marine Birds

There is a high probability of underestimating the impacts of oil spills on avian species potentially encountering oil, particularly seabirds. Despite being oiled, some birds are able to fly and may later be killed by the oil, far from the spill location. Often overlooked and understudied are the long-term, sublethal, chronic effects because of sublethal exposure to oil. These effects may persist for years after exposure, reducing the capacity of affected individuals within the population to recover, because of effects that may range from minor physiological disorders through damage to vital organs (i.e., liver and kidney) (Alonso-Alvarez et al., 2007). The long-term impacts of potential food stress for bird species from an altered ecosystem because of a catastrophic spill are unknown, but disturbances to the ecosystem can cause long-term sublethal impacts, including malnourishment and decreased reproductive success, which could have severe impacts to bird populations as seen after the *Exxon Valdez* catastrophic spill (Piatt and Anderson, 1996). Birds are top predators in the Gulf of Mexico and require a substantial supply of prey species to sustain their populations. Sublethal effects of oil could ultimately result in reductions in long-term survival or lower reproductive success for some species of birds (Fry et al., 1986; Leighton, 1993; Esler et al., 2000; Golet et al., 2003; Velando et al., 2010). In addition, even light oiling of avian eggs transferred via contact with contaminated breast feathers from an incubating female can be toxic to developing embryos (Albers, 1980; Albers and Heinz, 1983). Effects such as delayed sexual maturity of most seabird species, loss of breeding-age individuals, particularly females, may have long-term, population-level effects. Long-term, sublethal, chronic effects may exceed immediate losses because of direct mortality (i.e., oiled birds) if such residual effects influence a significant proportion of the population or disproportionately impact an important population segment (Newton, 1998; Peterson et al., 2003; Alonso-Alvarez et al., 2007). Depending on the effects, some populations could take years or decades before reaching a full recovery, and some may never recover.

5.2.2.2. Fish, Fisheries, and Essential Fish Habitat

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 (essential fish habitat) for spawning, breeding, feeding, and growth to maturity. Thus, a catastrophic spill that affects these areas could result in long-term impacts, including destruction to a portion of their habitats.

5.2.2.3. Marine Mammals

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, NOAA, NMFS, 2010c).

5.2.2.4. Sea Turtles

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 inches for males and 31 inches for females before they can reproduce (USDOC, NOAA, NMFS, 2010d). 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 cause anemia and immune suppression, or could lead to reproductive failure or death. As discussed in Section 4.2.2, shoreline oiling and response efforts may affect future population levels and reproduction (USDOI, NPS, 2010). The deaths of subadult and adult sea turtles may also drastically reduce the population.

5.2.2.5. Terrestrial Mammals and Reptiles

Beach Mice

Within the last 20-30 years, the combination of habitat loss because of beachfront development, isolation of remaining beach mouse habitat areas and populations, and 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 because of a catastrophic spill and cleanup activities would increase the threat of extinction.

Diamondback Terrapin

Habitat destruction, road construction, and drowning in crab traps 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.

5.2.2.6. Coastal Habitats

Coastal habitats serve important ecological functions, and the loss of vegetation in coastal areas could lead to erosion and permanent landloss.

Coastal Barrier Beaches and Associated Dunes

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.

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.

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. These contacts would not result in significant destabilization of the dunes. The long-term stressors to barrier beach communities caused by the physical effects and chemical toxicity of an oil spill may lead to decreased primary production, plant dieback, and hence further erosion.

Wetlands

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, including 20-25 percent of North America's puddle duck population. Therefore, loss of wetlands would also impact a significant portion of the waterfowl population.

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. This 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 ha/yr (10 mi^2/yr) over the next 50 years. Further, it was estimated that an additional net loss of 132,794 ha (512 mi^2) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al., 2003). Barras (2006) indicated an additional 217 mi^2 (562 km^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 basically removed 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, a poorly executed oil cleanup can result in additional impacts. Aggressive onshore and marsh cleanup methods have not yet been utilized and 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.)

5.2.2.7. Open-Water Habitats

Submerged Vegetation

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 for immature shrimp, black drum, spotted sea trout, juvenile southern flounder, and several other fish species, and they provide a food source for species of wintering waterfowl (Castellanos and Rozas, 2001; Short and Coles, 2001; Caldwell, 2003). Therefore, loss of submerged vegetation would impact these species.

Sargassum

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. The ultimate effects of toxins to *Sargassum* are unclear; however, it is evident that the accumulation provides a toxic environment for associated species, especially those that use the *Sargassum* as areas of refuge for larvae or other developmental stages (Unified Incident Command, 2010d). There would be noticeable effects on species that eat the plant material, such as sea turtles, and the death rate of *Sargassum* may be increased because of toxic substances, which would contribute to a major decline in its biomass. This would decrease available habitat for associated organisms and indirectly affect the survival rate and recruitment for associated fish species. The severity and duration of any toxic effects would be dependent on both the physical properties of the toxic components and their biological effects, such as how long it might take them to degrade, their solubility in water, and the degree that they accumulate in biological tissue.

5.2.2.8. Benthic Habitats

Shelf 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.

Hard-bottom communities 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 prevents drilling activity near sensitive hard-bottom habitats. Impacts would more likely be from low-level or long-term exposure. This type of exposure has the potential to greatly impact coral reef communities, resulting in impaired reef health. Impacts to a community in more turbid waters would be greatly reduced, as the species are tolerant of suspended sediments, and recovery would occur quicker.

Deepwater Soft-Bottom Benthic Communities

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 organisms ranging from a matter of days for bacteria and probably less than 1 year for most macrofauna and megafauna species. This could take longer for areas affected by direct oil contact in higher concentrations.

Deepwater Coral Benthic Communities

Deepwater corals are expected to be resistant to oiling, with little effect from low exposure. Many invertebrates associated with deepwater coral communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure. Recolonization of severely damaged or destroyed communities could take years to decades.

Deepwater Chemosynthetic Benthic Communities

While chemosynthetic communities that receive low quantities of well-dispersed oil undergoing biodegradation would likely experience little negative effect, recolonization of severely damaged or destroyed communities could take years to decades.

5.2.3. Socioeconomic Resources

5.2.3.1. Offshore and Onshore Archaeological Resources

While it is unlikely (Section 2.2.3.1), a known shipwreck could be impacted by the blowout itself or the subsequent oil spill; impacts (i.e., contamination) from the release of large quantities of dispersants associated with a deepwater, catastrophic blowout are possible. Because a site cannot be avoided unless its location in known, undiscovered shipwrecks are at a much higher risk as a result of a blowout. Long-term effects of oiling of prehistoric and historic archaeological resources are poorly understood; however, damage to the protective layer of corals and other organisms on shipwreck sites by oiling could alter the surrounding site dynamics and increase their degradation. In addition, onshore habitat degradation could lead to erosion, which would increase exposure to and subsidence of prehistoric and historic sites. Unlike biological resources that have the potential to recover, damage to archaeological resources from the spill or cleanup activities would be irreversible, leading to loss of important archaeological data needed for proper study and interpretation. Archaeological sites also provide recreational opportunities both offshore and onshore; therefore, the loss of a site would also have impacts on recreation.

5.2.3.2. Commercial Fishing

The Gulf is an important biologic and economic area in terms of seafood production and recreational fishing. According to NOAA, there are 3.2 million recreational fishermen in the Gulf of Mexico region who took 24 million fishing trips in 2008. Commercial fishermen in the Gulf harvested more than 1 billion pounds of finfish and shellfish in 2008 (USDOC, NOAA, 2010e). 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 fishers cannot make up losses in the remainder of the season, a substantial part of their annual income could be lost. While the commercial fishing industry of Texas did not sustain measurable direct or indirect economic effects following the 1979 *Ixtoc* 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). It is reasonable to assume that a negative perception could impact the value of commercial fish resources for several seasons.

5.2.3.3. Recreational Fishing

In 2008, over 24 million recreational fishing trips were taken in the Gulf of Mexico, which generated about $12 billion in sales, over $6 billion in value-added impacts, and over 100,000 jobs (USDOC, NOAA, NMFS, 2010b). Unlike commercial fishing, recreational fishing is concentrated during the summer months. Therefore, a catastrophic spill occurring at the beginning of the recreational fishing season and continuing through the season would result in the loss of millions of recreational fishing trips and billions in subsequent sales. For example, during the summer months, scheduled fishing tournaments are held that would be hard to reschedule. Normal direct income and indirect income to the communities that host these tournaments would be lost for that year.

5.2.3.4. Tourism and Recreational Resources

The longer-term implications of a catastrophic event on tourism would depend on the extent to which any structural/ecological damage can be repaired, as well as on the extent to which public confidence in the tourism industry can be restored. For example, a catastrophic oil spill would likely affect the fish populations in the affected waters to some extent. The most direct impact of this would be decreased recreational fishing activity in a region to the extent that the fish population has decreased. However, a region would not fully recover from the event until confidence in fishing is restored and the remaining fish population recovers. In addition, 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.

Oxford Economics (2010) conducted a study of recent catastrophic events in order to estimate the longer-term economic implications of the DWH oil spill. They estimate that the long-term economic damage from the spill could be between $7.6 and $22.7 billion. Analyzing previous oil spills and other catastrophic events, they also suggest that it could take 15-36 months for the tourism industry to recover to pre-spill levels. Given Florida's dependence on fishing and beach activities (as well as the overall size of its economy), this study suggests that the State would bear the majority of the economic damage from the spill. This study also points out the complicated set of economic and psychological forces that ultimately determine the extent to which the tourism and recreation industries would recover from a catastrophic oil spill.

5.2.3.5. Employment and Demographics

While a catastrophic spill could immediately impact several Gulf 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.

Catastrophic spills have a huge regional economic impact, as seen recently in the DWH event. It is estimated that the total economic consequences of the DWH event will lead to a net loss of just under $20 billion for the U.S. economy in 2010, which would lower U.S. economic growth in 2010 by roughly 0.1 percent and would reduce growth to a greater extent in the four states most affected.

5.2.3.6. Land Use and Coastal Infrastructure

Based on the rapid recovery of infrastructure that was heavily damaged by the catastrophic 2005 hurricane season, there are not expected to be any long-term impacts to land use and coastal infrastructure as a result of a catastrophic oil-spill event. However, BOEM would continue to monitor the post-spill, long-term recovery phase of the DWH event for any changes that indicate otherwise. A catastrophic spill could generate up to 60,000 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. This would be equivalent to 2-6 years of waste produced from OCS oil and gas activities in the Gulf of Mexico (Dismukes et al., 2007). However, landfill capacity is not expected to be an issue at any phase of the oil-spill event or the long-term recovery. According to USEPA, existing landfills that are receiving oil-spill waste from the DWH event have plenty of capacity to handle the expected waste volumes. The oil-spill waste that is being disposed of in landfills represents less than 7 percent of the total daily waste normally accepted at these landfills (USEPA, 2010a).

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. 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 can be influenced by the time of year the spill occurs, its location, and weather patterns, including hurricane landfalls (Dismukes, personal communication, 2010a).

5.2.3.7. Environmental Justice

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.

Suspension of Oil and Gas Activities

An analysis of socioeconomic characteristics shows that people of Cajun ethnicity in the Gulf States, 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 study in Louisiana found income inequality decreased during the oil boom of the 1980's and increased with the decline (Tolbert, 1995). Although we know that many oil- and gas-related service industries are cutting costs and putting off maintenance to defer massive layoffs in response to the oil-spill-caused deepwater drilling suspension and the slowed schedule for shallow-water drilling permits, we do not fully understand their long-term impacts.

Onshore and Offshore Cleanup Workers

By the end of a catastrophic spill, up to 50,000 personnel would be expected to be responding to the spill. The majority of these are field responders (United Incident Command, 2010f). As seen by the DWH event, the racial composition of cleanup crews was so conspicuous that Ben Jealous, the president of the National Association for the Advancement of Colored People (NAACP), 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" (NAACP, 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). Of the 38 accidents involving supertankers and resulting in large oil spills throughout the world, only seven studies on the repercussions of the exposure of spilled oils on human health have been completed. Aguilera et al. (2010) compiled and reviewed these studies 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 so far shown that the use of dispersants during the DWH event did not result in a presence of chemicals that surpassed human health benchmarks (Trapido, 2010). Longitudinal epidemiological studies of possible long-term health effects from exposure to either the DWH oil spill or dispersants, such as the possible bioaccumulation of toxins in tissues and organs, are lacking and the potential for the long-term human health effects are largely unknown (although the National Institutes of Health has proposed such a study).

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 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 OSHA released two matrices of gear requirements for onshore and offshore Gulf operations that are 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 could disproportionately affect seamen and onshore workers such as Cajuns, Vietnamese, Houma Indian, and African Americans.

During a recent National Institute of Environmental Sciences workshop regarding the health effects of the DWH oil spill, Chairperson Nancy E. Adler pointed to the uncertainty regarding health effects and these types of events, "While studies of previous oil spills provide some basis for identifying and mitigating the human health effects of these exposures, the existing data are insufficient to fully understand and predict the overall impact of hazards from the DWH oil spill on the health of individuals—including workers, volunteers, residents, visitors, and special populations" (Institute of Medicine, 2010). In order to address these data gaps, the National Institute of Environmental Sciences plans to begin a prospective study of the mental and physical health of about 50,000 workers who helped battle the spill.

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 a catastrophic spill could generate up to 60,000 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 DWH 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 could potentially receive more for future spills. For example, of the nine landfills approved by USEPA for oil-impacted solid materials, more than half of the waste was disposed of in four landfills that were located in areas where minority groups comprised the majority of the population (Hernandez, 2010). Disposal procedures for the DWH event 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 DWH liquid waste recovered; of this, 56 percent was manifested to mud facilities located in Venice, Plaquemines Parish, Louisiana, and Port Fourchon, 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 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 county means. Although, in the case of the DWH event, most of the cleanup occurred in the CPA and disposal occurred in both the CPA and WPA; this would likely happen should a future spill event occur in the CPA.

6. CUMULATIVE ENVIRONMENTAL AND SOCIOECONOMIC IMPACT

Like the recent, devastating hurricane seasons of 2005 and 2008, the DWH event has changed the environmental baseline of the Gulf of Mexico. Another catastrophic oil spill would make the resources of the Gulf even more susceptible to further impacts, adding to the cumulative effects of an already sensitive ecosystem.

The Gulf Coast has survived major natural and manmade disasters (i.e., hurricanes and oil spills), through which the people and environmental resources of the Gulf of Mexico and the Gulf Coast have repeatedly demonstrated their resiliency. While environmental and socioeconomic resources may recover from a natural or manmade disaster if given enough time between disasters, disasters happening in unison or within short periods of each other would make recovery more difficult.

The magnitude of OCS and non-OCS activity in the Gulf of Mexico is so immense that routine activities associated with a single OCS oil and gas activity (e.g., single lease sale, single well) have a minor to no incremental contribution to the impacts of cumulative activities. However, a catastrophic blowout and spill would have a major contribution to cumulative impacts.

7. SUMMARY OF IMPACTS

7.1. SUMMARY OF IMPACTS FROM PHASE 1 (INITIAL EVENT)

The initial phase of the catastrophic event analyzed in the Gulf of Mexico is a blowout causing an explosion and fire, possibly resulting in the sinking of the drilling rig or platform, which could potentially cause injuries and fatalities because of the explosion, fire, and structure failure. Impacts during Phase 1 would be limited to workers on the drilling rig or platform and response vessels and environmental resources in the immediate vicinity of the blowout. Air quality impacts include the emission of pollutants from the oil and the fire that are hazardous to human health and that can possibly be fatal if it involves high concentrations of H_2S or other highly toxic gases. Water quality impacts include localized water quality effects, which could include the release of a large amount of methane gas and the disturbance of a large amount of sediments over an extended area, if the blowout occurs outside the wellbore, below the seafloor.

An explosion would kill any birds resting on the platform, including birds protected under the Migratory Bird Treaty Act. Eruption of gases and fluids may generate significant pressure waves and noise to injure or kill individual animals in the vicinity, including federally listed threatened and endangered species under the ESA or MMPA. A shock wave underwater may also impact commercial and recreational fisheries in the area. Benthic communities beyond avoidance zones could be smothered. In addition to a large number of fatalities and injuries of people on the drilling rig or platform itself, commercial and recreational fishers and divers near the blowout could be injured or killed. The blowout could also damage any unidentified archaeological sites nearby.

7.2. Summary of Impacts from Phase 2 (Offshore Spill)

The second phase of the catastrophic event analyzed is an extended, offshore spill estimated to last 1-4 months for a blowout in shallow water and 3-5 months for a blowout in deep water, because of more difficult intervention. A large-scale response effort would be expected for a catastrophic spill, including tens of thousands of responders, several thousand vessels, and the release of a large amount of dispersants.

A catastrophic spill has the potential to cause population level impacts to offshore biological resources. Multiple Federal and State-listed, threatened and endangered species could be impacted in the water column or at the sea surface. In addition, natural processes (e.g., flocculation) and human intervention (i.e., subsea dispersants) could expose benthic communities and archaeological sites to oil. Additionally, known and previously undiscovered archaeological sites and benthic habitats could be damaged by bottom-disturbing activities associated with the response effort, including the anchoring of vessels. Pollutants in the spilled oil that are hazardous to response workers without protective equipment would be emitted into the air through evaporation and through in-situ or controlled burns of oil slicks.

Socioeconomic impacts would begin while the spill is still offshore. A large portion of the Gulf of Mexico EEZ and most of State waters could be closed to commercial and recreational fishing for several months, possibly causing the loss of revenue for an entire season or year. These closures may predominately affect minority or ethnic groups. Tourism may also be impacted because of either perceived damage to 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. Suspension of some oil and gas activities would possibly follow a catastrophic event, temporarily affecting jobs in the oil and gas industry.

7.3. Summary of Impacts from Phase 3 (Onshore Contact)

The third phase of the catastrophic event analyzed is oiling of the shoreline. Exponential increase of the length of impacted shoreline is expected as the spill would continue over several months, which would likely overwhelm response efforts. Because of longer intervention times, a deepwater blowout and spill could impact over 1,000 mi (1,609 km) of shoreline. While a catastrophic spill from a shallow-water blowout is expected to be a lower volume than a deepwater blowout, the site would generally be located closer to shore, allowing less time for oil to be weathered, dispersed, and recovered. This could result in more concentrated and toxic oiling of several hundred miles of shoreline for more than 2 months.

The severity of oiling would vary between heavy, moderate, light, and occasional tarballs. However, because of the length of shoreline that could be potentially oiled and the sensitivity of the Gulf Coast, a catastrophic spill could cause extensive habitat degradation. Loss of vegetation could lead to erosion and permanent landloss. Though response efforts (including the use of skimmers and booms) would decrease the amount of oil contacting the coastline, significant amounts of oil would remain to impact coastal water quality. Gulf of Mexico water quality is already rated as fair to poor, according to USEPA. Depending on timing and location, a catastrophic spill has the potential to cause population-level impacts on biological resources. Dozens of Federal and State-listed, threatened and endangered species could be impacted. Impacts on air quality may have adverse effects on oil-spill responders.

While cultural resources were recognized as significant early in the response and archaeologists are at present embedded in SCAT teams and consulting with cleanup crews, efforts to prevent coastal cultural resources from becoming contaminated by oil would likely be overwhelmed by the magnitude of shoreline impacted and/or in the event of a hurricane during the spill cleanup efforts. In addition to closures in Federal waters, portions to all of individual State waters would also be closed to commercial and recreational fishing. The economic impact of these closures would have a disproportional effect on minority and low-income groups, and shoreline impacts would generate additional subsistence-related effects. A catastrophic spill also has the potential to significantly impact the Gulf Coast recreation and tourism industries, particularly water-dependent and beach-dependent components of these industries. An influx of cleanup and relief workers would not fully offset economic impacts. The influx a large number of responders and the creation of staging areas because of a catastrophic spill would have temporary impacts (e.g., increased traffic congestion and some possible competing land-use issues) on land use and infrastructure. In addition, there is a potential for delays in cargo handling and slow vessel traffic because of decontamination operations at various sites along the marine transportation system.

7.4. Summary of Impacts from Phase 4 (Long-Term Impacts)

Phase 4 focuses on the long-term impacts of a catastrophic oil spill. While impacts to air and water quality may be shorter term, a catastrophic spill can have impacts on Gulf of Mexico ecosystems long after the well is capped or killed and cleanup activities have concluded. In some cases, marine ecosystems may take decades to fully recover or may recover to alternative states.

Coastal and offshore habitats serve important ecological functions. Onshore, the loss of vegetation could lead to erosion and permanent landloss. Offshore, repopulation of benthic communities could take longer for areas affected by direct oil contact in higher concentrations. For birds, fish, marine mammals and sea turtles, damage of habitats, loss of reproductively capable adults as well as juveniles, and sublethal impacts from oil exposure can lead to impaired reproduction. This can potentially reduce population levels. For example, a catastrophic spill could decrease available habitat for associated organisms and indirectly affect the survival rate and recruitment for associated fish species. In the case of birds, long-term, sublethal, chronic effects may exceed immediate losses because of direct mortality (i.e., oiled birds) if such residual effects influence a significant proportion of the population or disproportionately impact an important population segment. A catastrophic spill could cause the destruction of the remaining habitat of certain onshore species, such as the diamondback terrapin or beach mice.

A catastrophic spill can also have long-term impacts on socioeconomic resources. Positive employment impacts related to response activities are likely to be shorter term than the negative impacts. Catastrophic spills have a huge regional economic impact (billions of dollars), as recently seen with the DWH event. The longer-term implications for commercial and recreational fishing and tourism depend on the extent and perception of environmental damage. After the spill is stopped, the primary environmental justice concerns would be long-term health impacts of predominately minority workers and the disposal of oil-impacted solid waste in predominantly minority areas. Long-term impacts to land use and coastal infrastructure are not expected. Unlike biological or other socioeconomic resources that have the potential to recover, damage to archaeological resources from the spill or cleanup activities would be irreversible, leading to the loss of important archaeological data needed for proper study and interpretation.

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APPENDIX C

BOEM-OSRA CATASTROPHIC RUN

APPENDIX 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 120 days. The OSRA for this analysis was conducted for only the trajectories of oil spills from five hypothetical spill locations to various land segments. The probability of an oil spill contacting a specific land segment within a given time of travel from a certain location or 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 120 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 performed. Results from this trajectory analysis provide input to the final product by estimating where spills might travel on the ocean's surface and what land segments might be contacted if and when another catastrophic spill occurs, but it does not provide input on the probability of another catastrophic spill occurring.

OSRA Overview

The OSRA model, originally developed by Smith et al. (1982) and enhanced by this Agency over the years (Ji et al., 2002, 2004a, and 2004b), simulates oil-spill transport using model-simulated winds and ocean currents in the Gulf of Mexico. An oil spill on the ocean surface moves 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 shoreline. The frequencies of oil-spill contact are computed for designated oil-spill travel times (e.g., 3, 10, 30, or 120 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 segments of shoreline from the five launch points (LP) in the Gulf of Mexico, which are explained below.

There are factors not explicitly considered by the OSRA model that can affect the transport of spilled oil as well as the dimensions, volume, and nature of the oil spills contacting environmental resources or the shoreline. These include possible cleanup operations, chemical composition or biological weathering of oil spills, or the spreading and splitting of oil spills. The OSRA analysts have chosen to take a more environmentally conservative approach by presuming persistence of spilled oil over the selected time duration of the trajectories.

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 coastline segments by the total number of simulated oil spills from each of the five LP's. These ratios are the estimated probabilities of oil-spill contact from offshore activities at that geographic location, assuming spill occurrence.

Conducting an oil-spill risk analysis needs detailed information on ocean currents and wind fields (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 et al., 2004; Oey, 2005). 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 et al., 2004). This simulation covered the 7-year period, 1993 through 1999, 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.

Catastrophic OSRA Run Overview

A special OSRA run was conducted in order to estimate the impacts of a possible future catastrophic spill. Thus, assuming a hypothetical catastrophic oil spill occurred, this analysis emphasized modeling a spill that continued for 90 consecutive days with each trajectory tracked for up to 120 days. The OSRA for this analysis was conducted for only the trajectories of oil spills from five hypothetical spill locations to various land segments (**Figures C-1 and C-2**). The probability that an oil spill will contact a specific land segment within a given time of travel from a certain location or 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 120 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 the 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 was not performed. Results from this trajectory analysis provide input to the final product by estimating where spills might travel on the ocean's surface and what land segments might be contacted if and when another catastrophic spill occurs, but it does not provide input on the probability of another catastrophic spill occurring.

Trajectories of hypothetical spills were initiated every 1.0 day from each of the launch points over the simulation period from January 1, 1993, to December 31, 1998 (**Figure C-1**). 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.

These launch point locations were developed within the Gulf of Mexico region for the purpose of this analysis. Five launch points were identified and encompassed the approximate areas with the possibility of finding the largest oil volume within the following regions:

- Central Gulf of Mexico shelf area west of the Mississippi River;
- Central Gulf of Mexico shelf area east of the Mississippi River;
- Central Gulf of Mexico slope area;

- Western Gulf of Mexico shelf area; and
- Western Gulf of Mexico slope area.

Longitude	Latitude	Launch Point (LP)
-92.17851	28.98660	1
-88.15338	29.91388	2
-90.22203	27.31998	3
-96.76627	27.55423	4
-94.51836	27.51367	5

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 the five points. For each geologic play currently recognized, the undiscovered technically recoverable resource volume was allocated throughout the play area based on the likelihood of future oil discovery potential. The probability factor used to allocate undiscovered oil volumes to areas within the geologic play was based on the density of existing discoveries, the density of undrilled prospects on leased acreage, and the results from recent exploration activity. In areas where the potential for undiscovered technically recoverable resource volume exists for more than one geologic play, the oil volumes were aggregated. Results from the aggregation were used to identify five 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. After their selection, the five points were given to the OSRA analysts for use with the OSRA model.

Additionally, the total estimated oil-contacted area of water was also determined. The OSRA model integrates the spill velocities (a linear superposition of surface ocean currents and empirical wind drift) by integrating in time to produce the spill trajectories. The time step selected was 1 hour to fully utilize the spatial resolution of the ocean current field and to achieve a stable set of trajectories. The velocity field was bilinearly interpolated from the 3-hour grid to get velocities at 1-hour intervals.

The trajectories simulated by the 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. Therefore, OSRA model trajectories were analyzed up to 120 days. Any spill contacts occurring during this elapsed time are reported in the probability tables. Conditional probabilities of contact with land segments within 120 days of travel time were calculated for each of the hypothetical spill sites.

The probability estimates were tabulated as 90-day groupings of the 120-day trajectories, as averages for the 6 years of the analysis from 1993 to 1998. These groupings were treated as seasonal probabilities that corresponded with quarters of the year: Winter, Q1 (January, February, and March); Spring, Q2 (April, May, and June); Summer, Q3 (July, August, and September); and Fall, Q4 (October, November, and December). These 3-month probabilities can be used to estimate the average number of land segments (counties/parishes) contacted 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. The latest meteorological and oceanographic information in the Gulf of Mexico available to BOEM were for the years 1993-1998.

The area of ocean surface contacted by oil from the hypothetical spills was estimated by creating a grid of 1/6 degree longitude by 1/6 degree latitude. As the trajectories were computed, contact to the grid cells was tabulated. To estimate the area, the number of grid cells was multiplied by the approximate area of 342 square kilometers per grid cell. The number of grid cells and the approximate area of the ocean contacted by the spills were summarized at the same time intervals that were used for the land segment (county/parish boundary) tables (3, 10, 30, and 120 days).

Catastrophic OSRA Results and Discussion

It should be noted that the study area only extends somewhat into the Atlantic Ocean, where oil spills in the Gulf might be transported via the exiting Loop Current. However, on average, less than 0.5 percent of the simulated spills made it across the northern or southern Florida Straits boundary within 30 days, and only 1-2 percent within 120 days. The hypothetical spill trajectories from launch points in the western Gulf of Mexico (e.g., LP1, LP4, and LP5) have a much less chance of being transported through the Florida Straits than those in the central Gulf of Mexico (LP2 and LP3).

As one might expect, land segments closest to the spill sites had the greatest risk of contact. As the model run duration increases, more of the shoreline segments could have meaningful probabilities of contact (≥0.5%) (See **Tables C-1 through C-5** for the probabilities expressed as percent chance of one or more offshore spills ≥1,000 bbl contacting the areas noted in **Figure C-2**.). 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 120 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 120 days or more.

To summarize the differences between the LP's, a chart showing the estimated square area of each launch point for the 6-day intervals is shown (see **Figures C-3 through C-7** corresponding to LP's 1-5, respectively). The differences between the estimated spill areas from each LP can be explained by meteorological and oceanographic conditions.

- LP1—CPA, shelf area, west of the Mississippi River Delta, offshore south-central Louisiana, deepwater. Launch Point 1 is located near the Louisiana coast, and the fall circulation results in persistent and recurring coastal current from Louisiana waters toward Texas waters.

- LP2—CPA, shelf edge area, east of the Mississippi River Delta, south of the Alabama-Mississippi border, ultra-deepwater. Launch Point 2 is located near the Mississippi River Delta on the eastern side. The trajectories contact the coastline of Louisiana, Mississippi, Alabama, and Florida. Many of the trajectories are forced offshore by the wind drift and interact with the Loop Current and Loop Current eddies.

- LP3—CPA, shelf area, west of the Mississippi River delta, due south of New Orleans, deepwater. Launch Point 3 is located relatively far offshore and west of the Mississippi River Delta. The estimated area contacted by the spill is the largest of all the selected points, and the trajectories are influenced by the deepwater Loop Current eddies and offshore currents.

- LP4—WPA, shelf area, deepwater. Launch Point 4 is near the Texas coast in the western Gulf of Mexico. The trajectories from this launch point frequently contact land. The coastal flow near Texas, but to the south of the U.S./Mexico border, has a high fraction of northward currents, the wind is relatively persistent with a westward component, and the trajectories remain in a relatively smaller area.

- LP5—WPA, slope area, ultra-deepwater. Launch Point 5 is in the western Gulf of Mexico between the coast (LP4) and the central Gulf (LP3). The trajectories are forced by the Loop Current eddies that are somewhat weaker in this part of the Gulf of Mexico because these eddies dissipate kinetic energy as they drift to the west from their original separation zone.

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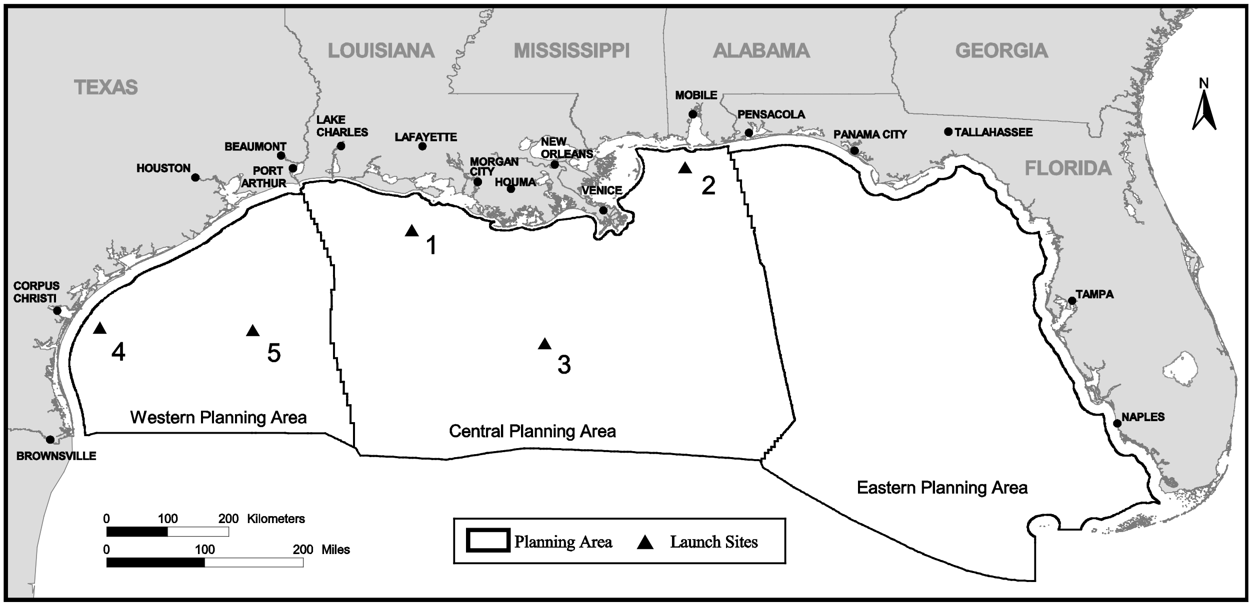

Figure C-1. Location of Five Hypothetical Oil-Spill Launch Points for OSRA within the Study Area.

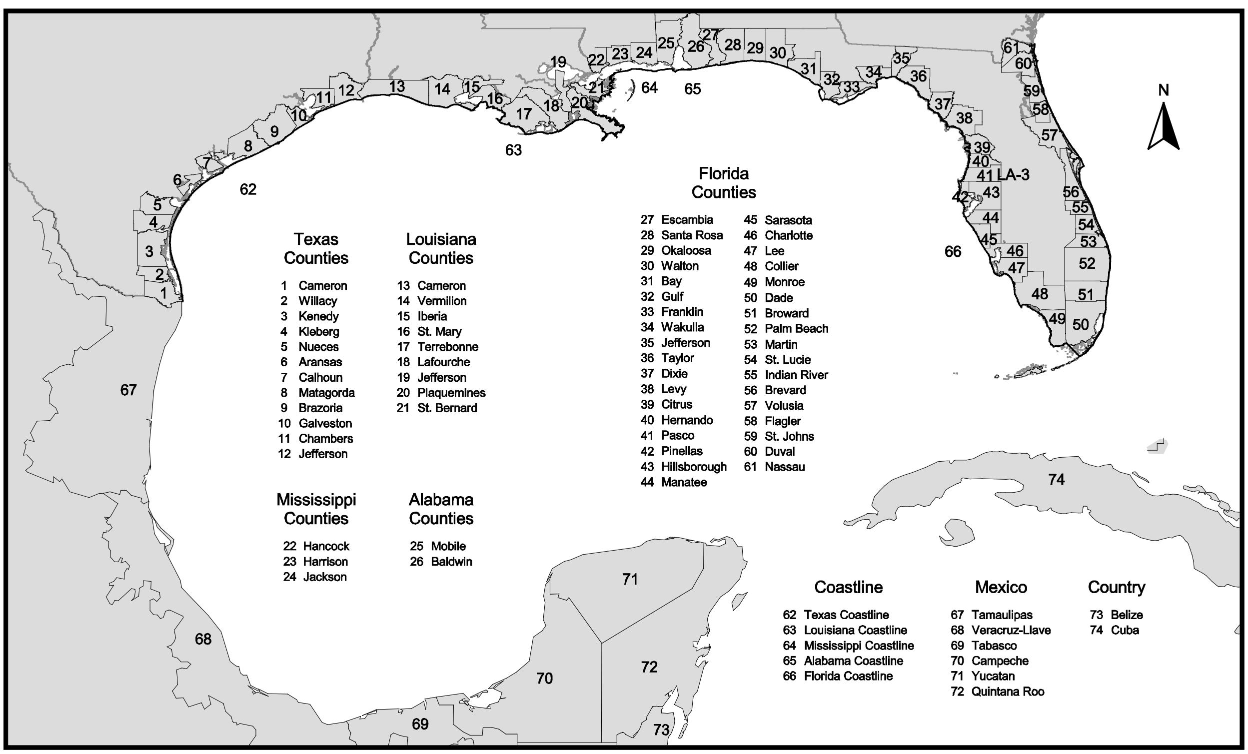

Figure C-2. Locations of Parishes, Counties, and Coastlines Examined in the Special OSRA Run Conducted in Order to Estimate the Impacts of a Possible Future Catastrophic Spill.

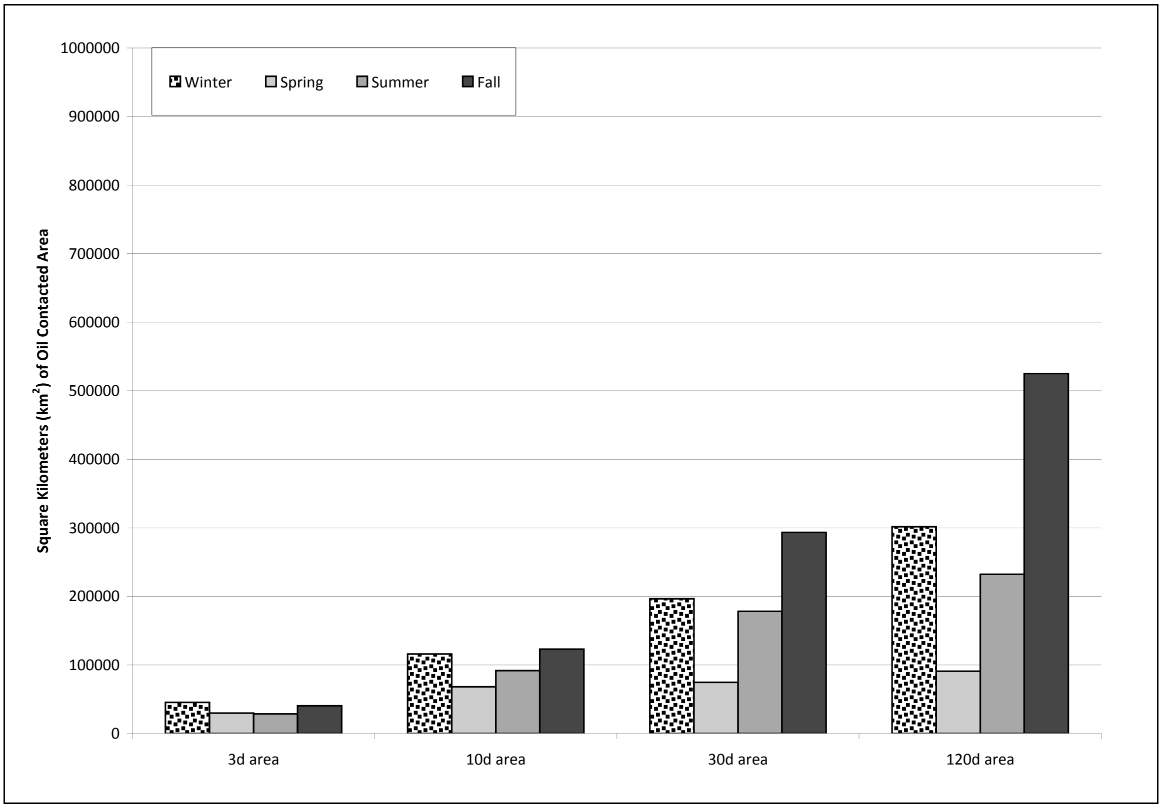

Figure C-3. Estimated Square Area of Launch Point One (LP 1) for 3, 10, 30, and 120 Days in Winter, Spring, Summer, and Fall.

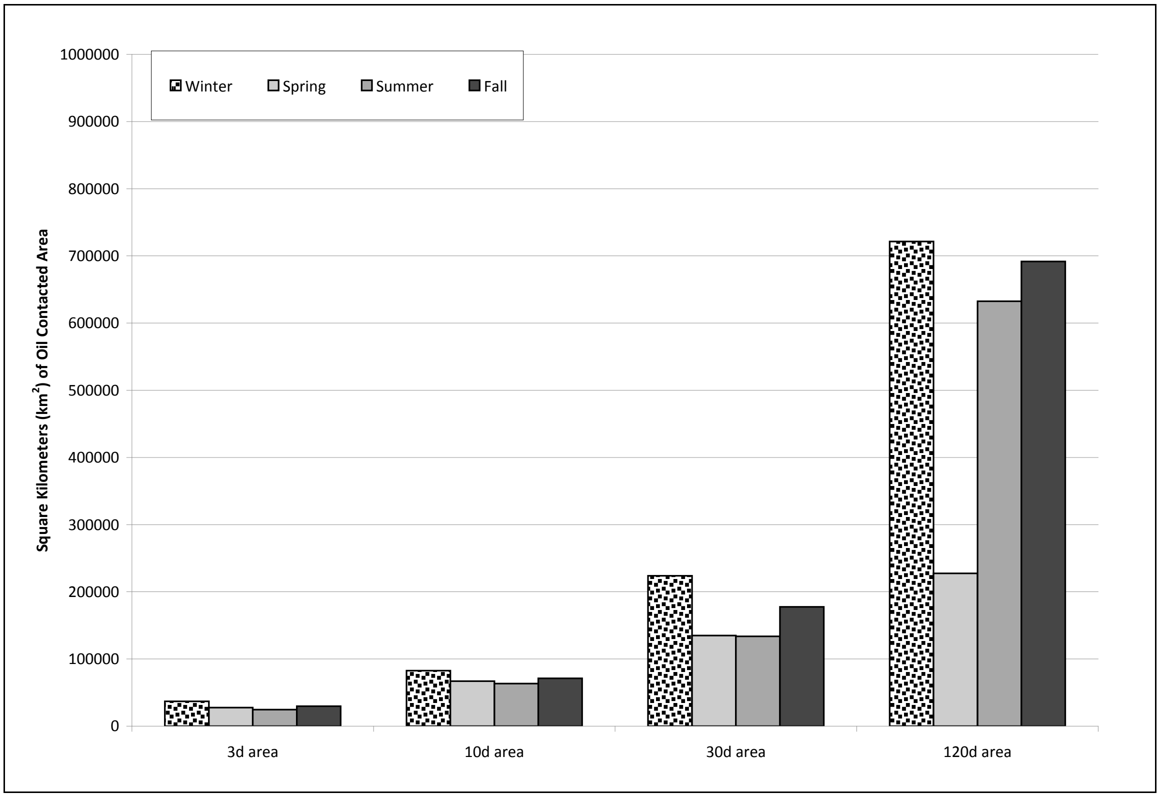

Figure C-4. Estimated Square Area of Launch Point Two (LP 2) for 3, 10, 30, and 120 Days in Winter, Spring, Summer, and Fall.

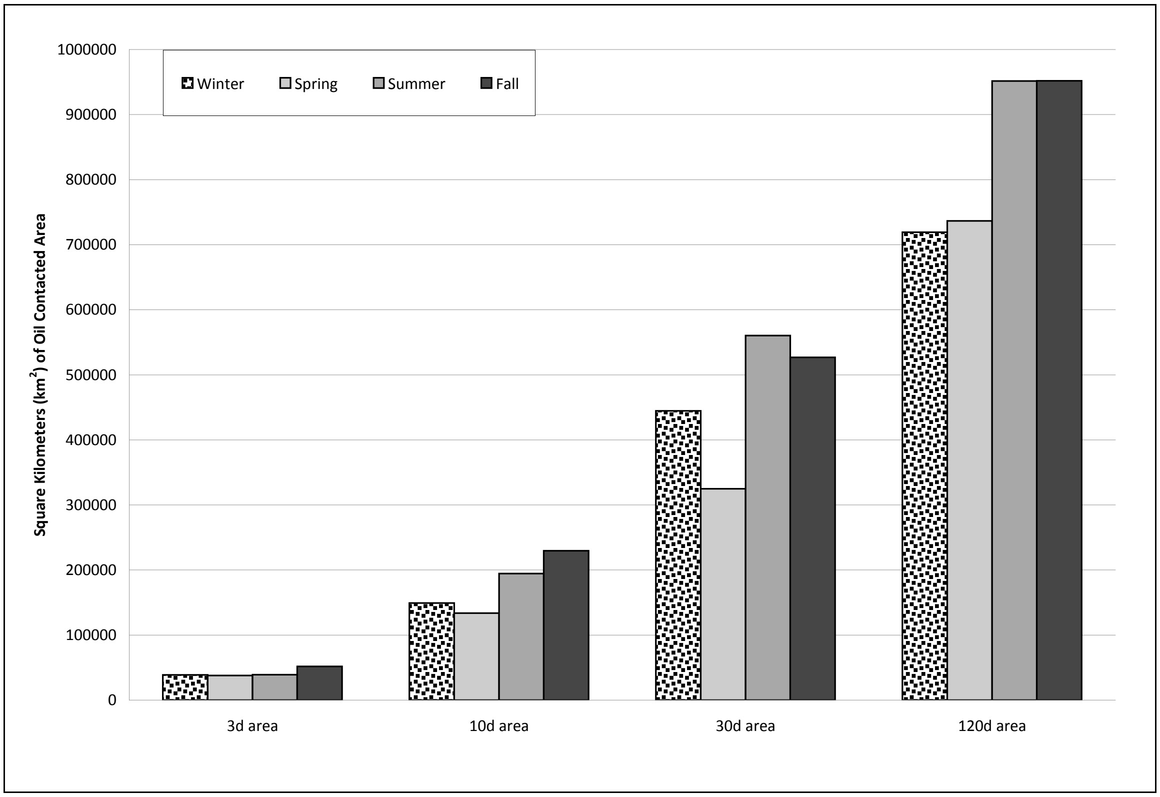

Figure C-5. Estimated Square Area of Launch Point Three (LP 3) for 3, 10, 30, and 120 Days in Winter, Spring, Summer, and Fall.

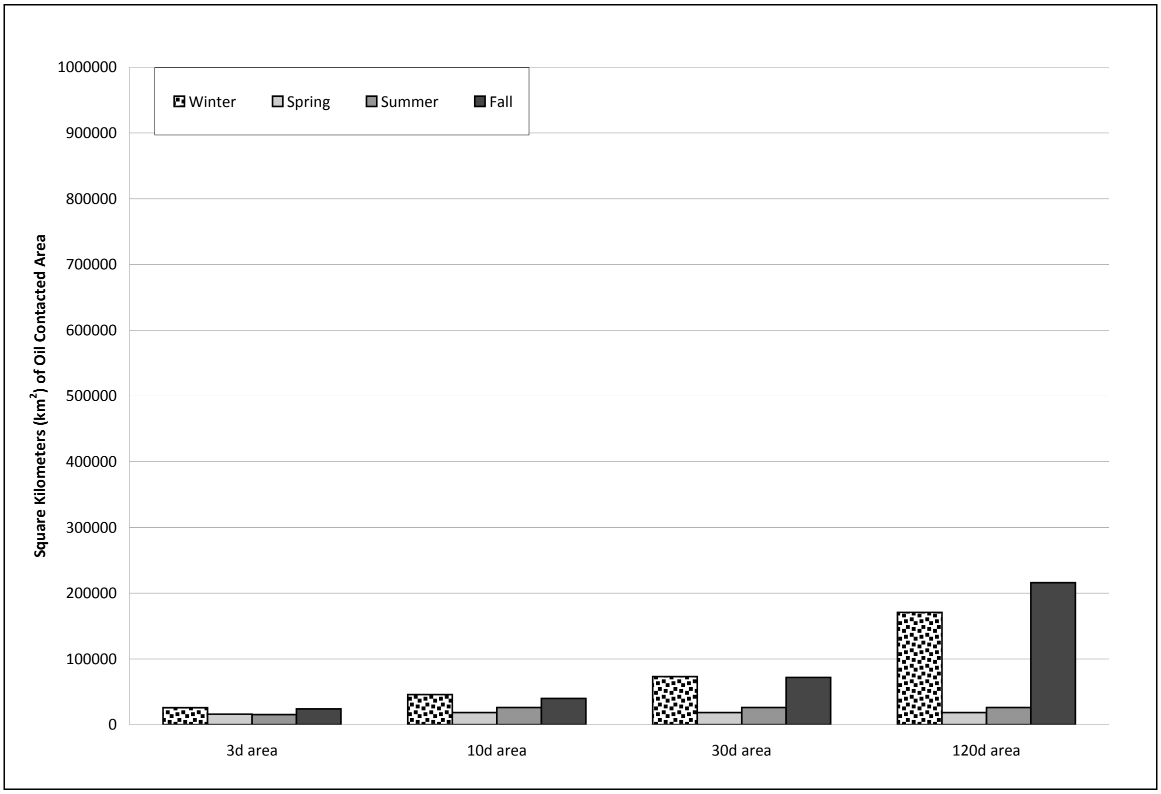

Figure C-6. Estimated Square Area of Launch Point Four (LP 4) for 3, 10, 30, and 120 Days in Winter, Spring, Summer, and Fall.

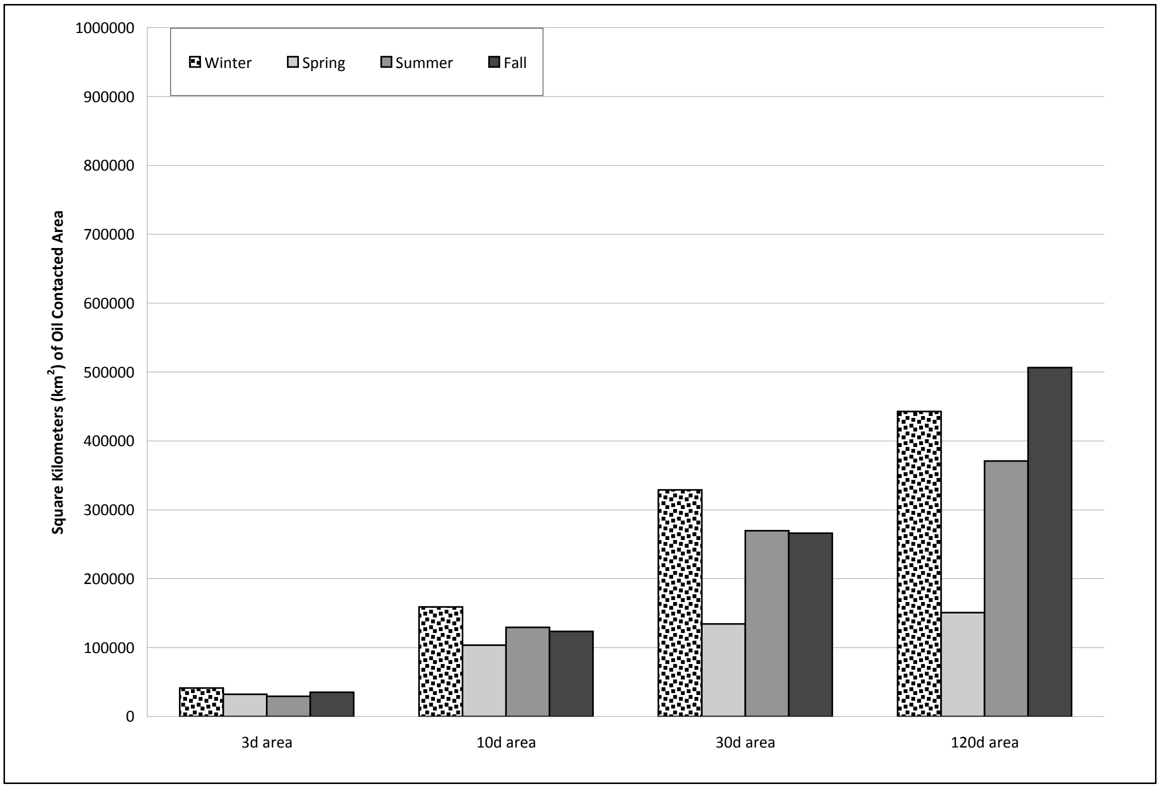

Figure C-7. Estimated Square Area of Launch Point Five (LP 5) for 3, 10, 30, and 120 Days in Winter, Spring, Summer, and Fall.

Table C-1

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point One Will Contact a Certain Parish, County, or Coastline within 120 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	120	3	10	30	120	3	10	30	120	3	10	30	120
ID	Name	Percent Chance															
1	Cameron, TX	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	2
2	Willacy, TX	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
3	Kenedy, TX	-	-	1	3	-	-	-	-	-	-	1	1	-	-	2	4
4	Kleberg, TX	-	-	-	1	-	-	-	1	-	-	1	1	-	-	1	3
5	Nueces, TX	-	-	1	4	-	-	-	-	-	-	1	2	-	-	1	3
6	Aransas, TX	-	-	2	4	-	-	-	-	-	-	2	2	-	-	2	4
7	Calhoun, TX	-	-	5	10	-	-	-	-	-	-	4	4	-	-	2	3
8	Matagorda, TX	-	1	13	17	-	-	1	1	-	-	3	4	-	1	9	11
9	Brazoria, TX	-	1	9	10	-	1	3	3	-	-	4	6	-	-	6	6
10	Galveston, TX	-	2	9	11	-	2	8	9	-	2	12	15	-	1	9	9
11	Chambers, TX	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
12	Jefferson, TX	-	2	5	6	-	5	9	9	-	2	9	10	-	3	6	6
13	Cameron, LA	2	10	13	15	5	35	41	41	-	7	18	20	2	13	16	19
14	Vermilion, LA	4	9	10	10	8	22	24	24	1	9	12	12	4	8	9	9
15	Iberia, LA	1	2	3	3	1	5	6	6	-	5	7	7	1	2	3	3
16	St. Mary, LA	-	1	1	1	-	1	1	1	-	-	-	-	-	-	-	-
17	Terrebonne, LA	-	1	1	1	-	2	2	2	-	-	5	6	-	1	1	1
18	Lafourche, LA	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
19	Jefferson, LA	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
21	St. Bernard, LA	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
62	Texas Coastline	-	6	45	68	-	8	23	24	-	5	37	47	-	6	38	52
63	Louisiana Coastline	8	23	28	30	14	64	75	76	2	21	43	49	6	23	30	32
64	Mississippi Coastline	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
67	Tamaulipas, Mexico	-	-	-	1	-	-	-	-	-	-	2	2	-	-	1	3

Note: Values of <0.5% are indicated by "-". Any areas where the percent chance within 120 days of all seasons are all <0.5% are not shown. See Figure C-1 for the location of Launch Point One. See Figure C-2 for the location of the named land areas.

Table C-2

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point Two Will Contact a Certain Parish, County, or Coastline within 120 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	120	3	10	30	120	3	10	30	120	3	10	30	120
ID	Name	Percent Chance															
1	Cameron, TX	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
2	Willacy, TX	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
3	Kenedy, TX	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
4	Kleberg, TX	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
7	Calhoun, TX	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
8	Matagorda, TX	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	2
9	Brazoria, TX	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
10	Galveston, TX	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-
12	Jefferson, TX	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
13	Cameron, LA	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
14	Vermilion, LA	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
17	Terrebonne, LA	-	-	3	4	-	-	-	-	-	-	-	1	-	-	-	1
18	Lafourche, LA	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1
19	Jefferson, LA	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1
20	Plaquemines, LA	1	14	21	23	-	3	4	6	1	8	20	25	2	21	27	28
21	St. Bernard, LA	-	4	5	5	-	1	2	3	1	7	14	16	-	8	9	10
22	Hancock, MS	-	1	2	4	-	2	2	2	-	2	3	3	1	3	5	5
23	Harrison, MS	2	3	4	5	-	4	4	4	1	3	4	4	1	2	3	3
24	Jackson, MS	7	11	11	13	5	11	12	12	1	3	4	4	6	12	13	14
25	Mobile, AL	11	14	14	15	11	16	17	17	4	8	9	10	8	11	12	13
26	Baldwin, AL	4	7	7	9	6	14	16	17	1	8	10	10	1	2	2	3
27	Escambia, FL	-	1	1	2	1	5	11	13	1	3	5	6	-	-	1	1
29	Okaloosa, FL	-	-	-	1	-	1	2	3	-	-	1	1	-	-	-	-
30	Walton, FL	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1
31	Bay, FL	-	-	-	1	-	2	3	5	-	-	1	2	-	-	-	-
32	Gulf, FL	-	-	-	-	-	1	3	5	-	-	1	1	-	-	-	-
33	Franklin, FL	-	-	-	-	-	-	-	3	-	-	1	2	-	-	-	-
34	Wakulla, FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
36	Taylor, FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
38	Levy, FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
49	Monroe, FL	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
50	Dade, FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
62	Texas Coastline	-	-	-	7	-	-	-	-	-	-	-	5	-	-	1	6
63	Louisiana Coastline	2	18	29	37	-	4	6	9	1	15	34	43	2	29	39	41
64	Mississippi Coastline	9	15	17	22	5	16	18	19	3	7	11	12	7	16	21	22
65	Alabama Coastline	15	21	21	24	18	30	34	34	5	16	19	20	9	13	14	15
66	Florida Coastline	-	2	2	6	1	10	20	36	1	3	10	14	-	-	1	2
67	Tamaulipas, Mexico	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1

Note: Values of <0.5% are indicated by "-". Any areas where the percent chance within 120 days of all seasons are all <0.5% are not shown. See Figure C-1 for the location of Launch Point Two. See Figure C-2 for the location of the named land areas.

Table C-3

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point Three Will Contact a Certain Parish, County, or Coastline within 120 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	120	3	10	30	120	3	10	30	120	3	10	30	120
ID	Name	Percent Chance															
1	Cameron, TX	-	-	-	2	-	-	-	-	-	-	-	2	-	-	-	2
2	Willacy, TX	-	-	-	3	-	-	-	-	-	-	-	2	-	-	-	3
3	Kenedy, TX	-	-	-	8	-	-	-	1	-	-	-	9	-	-	-	5
4	Kleberg, TX	-	-	1	6	-	-	-	-	-	-	-	4	-	-	1	6
5	Nueces, TX	-	-	1	6	-	-	-	-	-	-	-	2	-	-	1	2
6	Aransas, TX	-	-	-	5	-	-	-	1	-	-	-	3	-	-	-	2
7	Calhoun, TX	-	-	1	6	-	-	-	-	-	-	-	6	-	-	1	4
8	Matagorda, TX	-	-	2	17	-	-	3	4	-	-	-	11	-	-	1	6
9	Brazoria, TX	-	-	3	12	-	-	1	3	-	-	2	8	-	-	1	5
10	Galveston, TX	-	-	3	10	-	-	3	6	-	-	2	5	-	-	1	4
12	Jefferson, TX	-	-	1	4	-	-	7	9	-	-	1	1	-	-	-	2
13	Cameron, LA	-	-	1	4	-	-	11	12	-	1	1	4	-	-	-	4
14	Vermilion, LA	-	-	1	2	-	-	5	6	-	1	1	2	-	-	-	-
15	Iberia, LA	-	-	-	1	-	-	4	4	-	-	-	-	-	-	-	-
17	Terrebonne, LA	-	1	2	3	-	4	12	14	-	-	-	2	-	-	-	-
18	Lafourche, LA	-	-	1	1	-	2	8	10	-	-	1	2	-	-	-	-
19	Jefferson, LA	-	-	-	1	-	-	2	2	-	-	1	1	-	-	-	-
20	Plaquemines, LA	-	-	-	1	-	2	10	12	-	-	1	2	-	-	-	-
24	Jackson, MS	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
26	Baldwin, AL	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
31	Bay, FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
33	Franklin, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
49	Monroe, FL	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
50	Dade, FL	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
62	Texas Coastline	-	-	12	78	-	-	14	24	-	-	6	54	-	-	4	41
63	Louisiana Coastline	-	1	6	14	-	9	52	60	-	1	4	13	-	-	-	6
64	Mississippi Coastline	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
65	Alabama Coastline	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
66	Florida Coastline	-	-	-	1	-	-	1	4	-	-	-	2	-	-	-	2
67	Tamaulipas, Mexico	-	-	-	4	-	-	-	1	-	-	-	10	-	-	-	10
68	Veracruz-Llave, Mexico	-	-	-	-	-	-	-	-	-	-	1	7	-	-	-	1
69	Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

Note: Values of <0.5% are indicated by "-". Any areas where the percent chance within 120 days of all seasons are all <0.5% are not shown. See Figure C-1 for the location of Launch Point Three. See Figure C-2 for the location of the named land areas.

Table C-4

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point Four Will Contact a Certain Parish, County, or Coastline within 120 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	120	3	10	30	120	3	10	30	120	3	10	30	120
ID	Name	Percent Chance															
1	Cameron, TX	1	3	3	3	-	-	-	-	-	-	-	-	-	2	3	3
2	Willacy, TX	3	4	4	4	1	1	1	1	-	1	1	1	3	7	8	8
3	Kenedy, TX	10	22	23	23	7	9	9	9	3	9	9	9	10	21	22	23
4	Kleberg, TX	9	14	15	16	12	14	14	14	9	17	17	17	7	13	14	14
5	Nueces, TX	10	16	17	18	21	26	26	26	8	17	18	18	11	16	17	17
6	Aransas, TX	11	15	16	16	28	33	33	33	17	26	26	26	9	12	13	13
7	Calhoun, TX	7	12	13	14	12	15	15	15	18	25	26	26	7	11	12	12
8	Matagorda, TX	1	3	3	4	1	2	2	2	-	2	2	2	-	1	2	3
9	Brazoria, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
62	Texas Coastline	51	90	94	98	82	99	**	**	56	98	**	**	48	84	91	93
67	Tamaulipas, Mexico	-	1	2	2	-	-	-	-	-	-	-	-	-	-	1	1

Note: Values of <0.5%.are indicated by "-". Any areas where the percent chance within 120 days of all seasons are all <0.5% are not shown. Values of >99.5% are indicated by "**". See Figure C-1 for the location of Launch Point Four. See Figure C-2 for the location of the named land areas.

Table C-5

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point Five Will Contact a Certain Parish, County, or Coastline within 120 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	120	3	10	30	120	3	10	30	120	3	10	30	120
ID	Name	Percent Chance															
1	Cameron, TX	-	-	2	4	-	-	-	-	-	-	2	3	-	-	3	5
2	Willacy, TX	-	-	1	4	-	-	-	-	-	-	2	3	-	-	2	3
3	Kenedy, TX	-	1	8	14	-	-	1	1	-	-	4	7	-	-	6	9
4	Kleberg, TX	-	-	5	7	-	1	2	2	-	-	1	3	-	-	4	5
5	Nueces, TX	-	1	5	9	-	1	2	2	-	-	1	1	-	-	3	5
6	Aransas, TX	-	1	5	10	-	-	3	3	-	-	2	3	-	-	4	6
7	Calhoun, TX	-	2	10	20	-	3	11	12	-	-	7	9	-	1	5	7
8	Matagorda, TX	-	1	8	14	-	18	29	30	-	2	12	21	-	2	9	15
9	Brazoria, TX	-	-	3	4	-	9	13	13	-	-	7	12	-	1	4	6
10	Galveston, TX	-	1	2	4	-	3	11	13	-	-	5	12	-	1	2	3
12	Jefferson, TX	-	-	-	1	-	-	12	15	-	-	1	4	-	-	-	1
13	Cameron, LA	-	-	-	1	-	1	5	6	-	-	6	8	-	-	-	-
14	Vermilion, LA	-	-	-	-	-	-	2	3	-	-	1	2	-	-	-	-
20	Plaquemines, LA	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
62	Texas Coastline	-	7	50	91	-	35	85	90	-	2	43	79	-	5	43	65
63	Louisiana Coastline	-	-	-	1	-	1	8	9	-	-	8	11	-	-	-	-
67	Tamaulipas, Mexico	-	-	1	6	-	-	-	-	-	-	3	7	-	-	2	11
68	Veracruz-Llave, Mexico	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

Note: Values of <0.5% are indicated by “-”. Any areas where the percent chance within 120 days of all seasons are all <0.5% are not shown. See Figure C-1 for the location of Launch Point Five. See Figure C-2 for the location of the named land areas.

APPENDIX D

ESSENTIAL FISH HABITAT ASSESSMENT

D. ESSENTIAL FISH HABITAT ASSESSMENT

D.1. PROPOSED ACTIONS

Purpose of and Need for the Proposed Actions (Chapter 1.1)

The proposed Federal actions addressed in this environmental impact statement (EIS) are 10 areawide oil and gas lease sales, 5 each in the Western Planning Area (WPA) and Central Planning Area (CPA) of the Gulf of Mexico (Gulf) Outer Continental Shelf (OCS) (**Figure 1-1**). Under the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017* (Five-Year Program), two sales would be held each year—one in the WPA and one in the CPA (**Table 1-1**). The first two proposed lease sales are WPA Lease Sale 229 scheduled for late 2012 and CPA Lease Sale 227 scheduled for 2013. The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources. The proposed lease sales will provide qualified bidders the opportunity to bid upon and lease acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas. This EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. This EIS will be the only National Environmental Policy Act (NEPA) document prepared for proposed WPA Lease Sale 229 and proposed CPA Lease Sale 227. An additional NEPA review will be conducted for each subsequent proposed lease sale in the Five-Year Program.

Prelease Process (Chapter 1.4)

Scoping for this EIS was conducted in accordance with Council Environmental Quality (CEQ) regulations implementing NEPA. The Bureau of Ocean Energy Management (BOEM) also conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for the proposed lease sales and this EIS. Key agencies and organizations included the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), U.S. Department of Defense (USDOD or DOD), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), State Governors' offices, and industry groups. On June 20, 2011, the Area Identification (Area ID) decision was made. One Area ID was prepared for all proposed lease sales. The BOEM mailed copies of the Draft Multisale EIS for review and comment to public and private agencies, interest groups, and local libraries. To initiate the public review and comment period on the Draft Multisale EIS, BOEM published a Notice of Availability (NOA) in the *Federal Register* on December 30, 2011. Additionally, public notices were mailed with the Draft Multisale EIS and placed on BOEM's Internet website (http://www.boem.gov/).

A consistency review will be performed and a Consistency Determination (CD) will be prepared for each affected State prior to each proposed lease sale. To prepare the CD's, BOEM reviews each State's Coastal Management Program (CMP) and analyzes the potential impacts as outlined in this EIS, new information, and applicable studies as they pertain to the enforceable policies of each CMP. Based on the analyses, the BOEM Director makes an assessment of consistency, which is then sent to each State with the Proposed Notice of Sale (NOS).

The Final Multisale EIS will be published approximately 5 months prior to the first proposed sale, WPA Lease Sale 229, which is scheduled for late 2012. To initiate the public review and 30-day minimum comment period, BOEM will publish a NOA in the *Federal Register*. The BOEM will send copies of this Final Multisale EIS for review and comment to public and private agencies, interest groups, and local libraries. After the end of the comment period, the U.S. Department of the Interior (USDOI or DOI) will review the EIS and all comments received on the Final Multisale EIS.

The EIS is not a decision document. A Record of Decision (ROD), which is the last step in this NEPA process, will identify the alternative chosen. The ROD will summarize the proposed action and the alternatives evaluated in the EIS, the conclusions of the impact analyses, and other information considered in reaching the decision. All comments received on the Final Multisale EIS will be addressed in the ROD.

A Proposed NOS will become available to the public 4-5 months prior to a proposed lease sale. If the decision by the Assistant Secretary of the Interior for Land and Minerals (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 sale date, as required by the OCS Lands Act.

Postlease Activities (Chapter 1.5)

Measures to minimize potential impacts are an integral part of the OCS Program. These measures are implemented through lease stipulations, operating regulations, Notices to Lessees and Operators (NTL's), and project-specific requirements or approval conditions. These 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.

A geological and geophysical (G&G) permit must be obtained from BOEM prior to conducting off-lease geological or geophysical exploration or scientific research on unleased OCS lands or on lands under lease to a third party (30 CFR 551.4 (a) and (b)). Geological investigations include various seafloor sampling techniques to determine the geochemical, geotechnical, or engineering properties of the sediments.

Formal exploration plans (EP's) and development plans (Development Operations and Coordination Documents [DOCD's]) (30 CFR 550.211 and 550.241) with supporting information must be submitted for review and approval by BOEM before an operator may begin exploration, development, or production activities on any lease. Supporting environmental information, archaeological reports, biological reports (monitoring and/or live-bottom survey), and other environmental data determined necessary must be submitted with an OCS plan.

A Programmatic EA must be completed to evaluate the potential effects of the deepwater technologies and operations (USDOI, MMS, 2000). The EP describes exploration activities, drilling rig or vessel, proposed drilling and well-testing operations, environmental monitoring plans, and other relevant information, and includes a proposed schedule of the exploration activities. Before any development operations can begin on a lease in a proposed lease sale area, a DOCD must be submitted to BOEM for review and decision. A DOCD describes the proposed development activities, drilling activities, platforms or other facilities, proposed production operations, environmental monitoring plans, and other relevant information, and it includes a proposed schedule of development and production activities.

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. New or unusual technologies (NUT's) may be identified by the operator in its EP, deepwater operations plan (DWOP), and DOCD or through BOEM's plan review processes. The operating procedures developed during the engineering, design, and manufacturing phases of the project, coupled with the results (recommended actions) from hazard analyses performed, will be used to develop the emergency action and curtailment plans. The lessee must use the best available and safest technology to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow.

Prior to conducting drilling operations, the operator is required to submit and obtain approval for an APD. Besides the application process, the lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations.

A permanent abandonment includes the isolation of zones in the open wellbore, plugging of perforated intervals, plugging the annular space between casings (if they are open), setting a surface plug, and cutting and retrieving the casing at least 15 feet (ft) (5 meters [m]) below the mudline. This also must be addressed in the application.

Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies, including DOI, the Department of Transportation (DOT), the U.S. Army Corps of Engineers (COE), the Federal Energy Regulatory Commission, and the USCG. Pipeline applications are usually submitted and reviewed separately from DOCD's. Pipeline applications may be for on-lease pipelines or rights-of-way for pipelines that cross other lessees' leases or unleased areas of the OCS. Pipeline permit applications to the Bureau of Safety and Environmental Enforcement (BSEE) include the pipeline location drawing, profile drawing, safety schematic drawing, pipe design data, a shallow hazard survey report, and an archaeological report, if applicable. The BSEE evaluates the design, fabrication, installation, and maintenance of all OCS pipelines. Applications for pipeline decommissioning must also be submitted for BOEM review and approval. Decommissioning applications are evaluated to ensure they will render the pipeline inert and/or to minimize the potential for the pipeline becoming a source of pollution by flushing and plugging the ends and to minimize the likelihood that the decommissioned line will become an obstruction to other users of the OCS by filling it with water and burying the ends.

The BSEE will provide for both an annual scheduled inspection and a periodic unscheduled (unannounced) inspection of all oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation. The lessee is required to use the best available and safest drilling technology in order to enhance the evaluation of conditions of abnormal pressure and to minimize the potential for the well to flow or kick. Because blowout preventers (BOP's) are important for the safety of the drilling crew, as well as the rig and the wellbore itself, BOP's are regularly inspected, tested, and refurbished. The BSEE's responsibilities under the Oil Pollution Act of 1990 (OPA) include spill prevention, review, and approval of oil-spill-response plans (OSRP's); inspection of oil-spill containment and cleanup equipment; and ensuring oil-spill financial responsibility for facilities in offshore waters located seaward of the coastline or in any portion of a bay that is connected to the sea either directly or through one or more other bays. The responsible party for covered offshore facilities (COF's) must demonstrate oil-spill financial responsibility (OSFR), as required by BOEM regulation 30 CFR 553. Under 30 CFR 250.1500 Subpart O, BSEE has outlined well control and production safety training program requirements for lessees operating on the OCS.

Alternatives (Chapter 2)

Alternative A—The Proposed Action: This is BOEM's preferred alternative. This alternative would offer for lease all unleased blocks within the WPA and CPA for oil and gas operations (**Figure 2-1**).

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

Alternative C—No Action: This is the cancellation of a proposed WPA or CPA lease sale. Any potential environmental impacts resulting from a proposed WPA or CPA lease sale would not occur or would be postponed. This is also analyzed in the EIS for the Five-Year Program on a nationwide programmatic level.

D.2. Guidance and Stipulations

The BOEM Topographic Features Banks, Live-Bottom (Pinnacle Trend Features), and Live Bottom (Low Relief Features) Stipulations were formulated over 20 years ago and were based on consultation with various Federal agencies and comments solicited from State, industry, environmental organizations, and academic representatives. These stipulations address conservation and protection of essential fish habitat/live-bottoms areas. The stipulations include exclusion of all oil and gas activity (structures, drilling, pipelines, production, etc.) on or near live-bottom areas (both high-relief and low-relief), mandatory shunting of drilling muds and cuttings near high-relief features, relocation of operations including pipelines away from essential fish habitat/live bottoms, and possible monitoring to assess the impact of the activity on the live bottoms. A continuous annual monitoring study has been ongoing at the East and West Flower Garden Banks since 1988.

Mitigating measures that are a standard part of the Bureau of Ocean Energy Management's OCS Program limit the size of explosive charges used for platform removal, require placing explosive charges at least 15 ft (5 m) below the mudline, establish No Activity and Modified Activity Zones around high-relief live bottoms, and require remote-sensing surveys to detect and avoid biologically sensitive areas such as low-relief live-bottoms, pinnacles, and chemosynthetic communities.

In 2009, NTL 2009-G39 ("Biologically Sensitive Areas of the Gulf of Mexico") and NTL 2009-G40 ("Deepwater Benthic Communities") were produced; these now supersede the previous guidelines for these features found in NTL 2004-G05 and NTL 2000-G20, respectively (USDOI, MMS, 2009). They offer guidance on the regulations at 30 CFR 550.216(a), 30 CFR 550.247(a), 30 CFR 550.221(a), 30 CFR 250.552(a), and 30 CFR 550.282. These are information regulations for EP, DOCD's, and development and production plans and monitoring programs, plans, and report regulations. The NTL 2009-G39 changes the water depth applicability of NTL 2004-G05 from 400 m (1,312 ft) to 300 m (984 ft), makes minor changes to the list of affected OCS blocks, adds regulatory references, updates an NTL reference, makes minor administrative changes, and adds a guidance document statement. It still explains the Topographic Feature, Live Bottom (Pinnacle Trend Features), and Live Bottom (Low Relief) Stipulations. The NTL 2009-G40 broadens the scope of the previous NTL 2000-G20 to cover all high-density deepwater benthic communities (not just high-density chemosynthetic communities), changes the definition of deepwater from 400 m (1,312 ft) to 300 m (984 ft) and increases the separation distance from muds and cuttings discharge locations from 457 m (1,500 ft) to 610 m (2,000 ft).

D.3. HABITATS

Gulf of Mexico Essential Fish Habitat Program and Policies

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 600) on January 17, 2002. Certain OCS activities authorized by BOEM may result in adverse effects to EFH, and therefore, require EFH consultation.

In March 2000, this Agency consulted with NMFS's Southeast Regional Office in preparing a NMFS regional finding for the Gulf Region that allows BOEM to incorporate the EFH assessments into NEPA documents. The BOEM consulted on a programmatic level, by letters of July 1999 and August 1999, to address EFH issues for certain BOEM Outer Continental Shelf activities (plans of exploration and production, pipeline rights-of-way, and platform removals).

Following the *Deepwater Horizon* event on July 30, 2010, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) requested reinitiation of the Endangered Species Act (ESA) consultation with both NMFS and FWS. The NMFS responded with a letter to BOEMRE on September 24, 2010. The EFH consultation was also addressed in the NMFS letter. A new EFH consultation has been initiated between BOEM's Gulf of Mexico OCS Region and NMFS Southeast Region. This is a biological assessment, which includes summaries of the WPA and CPA proposed actions, impacts, and relevant NTL's; and descriptions of managed species and EFH's. Based on the most recent and best available information at the time, BOEM will also continue to closely evaluate and assess risks to managed species and identified EFH in upcoming environmental compliance documentation under NEPA and other statutes. The EFH's that are covered in this EIS are water column, wetlands, seagrass communities/aquatic macrophytes, topographic features, live bottoms, *Sargassum*, chemosynthetic and nonchemosynthetic deepwater benthic communities, and soft-bottom deepwater benthic communities. These habitats are described and the impacts from a WPA and CPA proposed action are summarized in this Appendix. Each EFH will have the corresponding chapters from this EIS in parentheses for reference.

Water Column (Chapters 4.1.1.2.1.1. 4.1.1.2.2.1, 4.2.1.2.1.1, and 4.2.1.2.2.1)

Over 150 rivers empty out of North America into the Gulf (Gore, 1992, p. 127). The rivers emptying into the Gulf bring freshwater and sediment into coastal waters (Gore, 1992, pp. 127-131), which affects the water quality of these waters. The water cycle may introduce chemical and physical factors that alter the condition of the natural water (such as the addition of waterborne pollutants or the addition of warmer water into the Gulf). The leading source of contaminants that impair coastal water quality is urban runoff; which includes suspended solids, heavy metals and pesticides, oil and grease, and nutrients. Other pollutant source categories include agricultural runoff, municipal point sources, industrial sources, hydromodification (e.g., dredging), and vessel sources (e.g., shipping, fishing, and recreational boating). The zone of hypoxia on the Louisiana-Texas shelf occurs seasonally and is affected by the timing of the Mississippi and Atchafalaya Rivers' discharges carrying nutrients to the surface waters. The hypoxic conditions last until local wind-driven circulation mixes the water again. The water offshore of the Gulf's coasts can be divided into two regions: shallow <1,000 ft (305 m) and deep water ≥1,000 ft (305 m). Waters on the continental shelf at 0-200 m (0-656 ft) and on the slope at 200-2,000 m (656-6,562 ft) are heavily influenced by the Mississippi and Atchafalaya Rivers. In the Gulf of Mexico, pH ranges from approximately 8.1 to 8.3 at the surface (Gore, 1992, p. 87), salinity of the Gulf is generally 36 parts per thousand, and surface temperatures range from 29 ºC (84 ºF) to 19 ºC (65 ºF) (Gore, 1992, p. 79).

Gulf Stream

The Loop Current and its associated eddies create a dynamic zone with strong divergences and convergences that concentrate and transports plankton (this includes larvae from both oceanic and continental shelf species).

Estuarine

Wetlands (Chapters 4.1.1.4.1 and 4.2.1.4.1)

In general, coastal wetland habitats occur as bands around waterways. They are broad expanses of saline, brackish, and freshwater marshes; mud and sand flats; cypress-tupelo and mangrove swamps; and bottomland hardwood forests. Saline and brackish habitats support sharply delineated and segregated stands of single plant species. Fresh and low-salinity environments support more diverse and mixed communities of plants. High organic productivity and efficient nutrient recycling are characteristic of coastal wetlands. These wetland corridors also function as floodwater retention and purification areas as well as sites for local aquifer recharge. Different wetland habitats include the Laguna Madre, the Chenier Plain, and the Mississippi River Delta Complex. These are important areas for many estuarine dependent species.

Seagrass Communities/Aquatic Macrophytes (Chapters 4.1.1.5.1 and 4.2.1.5.1)

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 submerged aquatic vegetation provide important nursery and permanent habitat for sunfish, killifish, immature shrimp, crabs, drum, trout, flounder, and several other nekton species, and 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). These habitats are found in some capacity throughout the Gulf.

Structural Habitats

Oysters

Oysters are unique in that they are a substrate and a fisheries species. They provide hard substrate with complex structure for inshore species, including other oysters (all structure provides hiding places/refuge). They are also an important prey species and are discussed later in this Appendix. In the coastal areas off the United States, the oyster reefs in the Gulf of Mexico were evaluated as being in fair condition (Beck et al., 2001).

Topographic Features (Chapters 4.1.1.6.1 and 4.2.1.7.1)

Details of the restrictions are described in this Agency's NTL 2009-G39. The Biological Stipulation Map Package (http://www.boem.gov/Regulations/Notices-To-Lessees/Notices-to-Lessees-and-Operators.aspx) includes drawings of each bank with associated protection zones. Topographic features are hard-bottom habitats and are rare compared with the ubiquitous soft bottoms in the Gulf (Parker et al., 1983). They are typically upthrusts of rock due to uplift (salt diapirs) by underlying layers of salt deep under the seafloor. Some others, such as the South Texas Banks, are relic coral reefs left over from the last sea-level low stand (about 10,000 years ago). These topographic highs, or subsea banks, provide an island of hard substrate in a virtual ocean of soft bottoms. **Figure 4-5** depicts the location of protected topographic features in the Gulf. **Figure 4-5** depicts the location of 37 protected topographic features in the Gulf; 21 in the WPA and 16 in the CPA.

Live Bottoms (Pinnacle Trend [Chapter 4.2.1.6.1.1] and Low Relief [Chapter 4.2.1.6.2.1])

The northeastern portion of the CPA exhibits a region of high topographic relief known as the "Pinnacle Trend" at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon. The Pinnacle Trend spreads over a 103 x 26 km area (64 x 16 mi) in water depths of 60-200 m (200-650 ft) (**Figure 4-37**). High-relief features consist of pinnacles, flat-top reefs, reef-like mounds, patch reefs, and isobath-parallel ridges. Low-relief features include fields of small seafloor mounds that rise only a meter or two from the seafloor but provide hard surfaces for encrusting and attached epifauna.

Low-relief, hard-bottom features are located on the inner and middle Mississippi-Alabama shelf. These features include isolated low-relief, reef-like structures; rubble fields; low-relief flat rocks (e.g., 6 m long and 60 cm thick; 20 ft long and 2 ft thick); limestone ledges (e.g., 4 m [13 ft] high); rocky outcrops off Mobile Bay (18- to 40-m [59- to 131-ft] depth range; 5 m wide and 2 m high; 16 ft wide and 7 ft high); and clustered reefs (e.g., tens of meters across and 3 m [10 ft] high) (Schroeder et al., 1988; Schroeder, 2000). Hard-bottom features on the Mississippi-Alabama-Florida Shelf (MAFLA) typically provide reef habitat for tropical organisms, including sessile epifauna (soft corals, nonreef-building hard corals, sponges, bryozoans, crinoids) and fish; these areas are typically of low relief (<1 m; 3 ft) (Thompson et al., 1999). Many of these live bottom areas are found in the Eastern Planning Area and a small northeastern portion of the CPA. Hard bottom areas include De Soto Canyon, Florida Middle Grounds, Pulley Ridge, Steamboat Lumps, Madison Swanson, and the Sticky Grounds. Other low-relief live bottoms include seagrass communities, and these are covered in **Chapters 4.1.1.5 and 4.2.1.5** in this EIS and under the heading "Seagrass Communities/Aquatic Macrophytes" in this Appendix. The seagrass communities are found nearshore in the CPA with a small amount found in federal waters in the Eastern Planning Area (off the Florida coast).

Sargassum *(Chapters 4.1.1.7.1 and 4.2.1.8.1)*

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 Gulf is mainly comprised of *S. natans* and *S. fluitans* (Stoner, 1983; Lee and Moser, 1998; Littler and Littler, 2000). Both species of macrophytes (aquatic plants) are hyponuestonic (living immediately below the surface) and fully adapted to a pelagic existence (Lee and Moser, 1998). *Sargassum* serves as nurseries, sanctuaries, and forage grounds for both commercially and recreationally exploited species.

Manmade Structures

While these are not identified or described by NMFS as EFH, manmade structures serve as important habitat for many species. When manmade reefs are constructed, they provide new primary hard substrate similar in function to newly exposed hard bottom, with the additional benefit of substrate extending from the bottom to the surface. Reef structures of high profile seem to yield generally higher densities of managed and nonmanaged pelagic and demersal species than a more widespread, lower profile natural hard bottom or reef (South Atlantic Fishery Management Council, 1998). Wilson et al. (2003) reported fish densities as much as 1,000 times larger on platforms compared with surrounding mud bottom habitats and even equal to or greater than natural reef habitats such as the Flower Garden Banks. The benefits of artificial reefs created by the installation of energy production platform structures are well documented in Gulf waters off the coast of Texas and Louisiana. More than 400 oil and gas platforms are also used as artificial reefs after they are decommissioned. Jetties also provide hard substrate for intertidal species and rigs also create artificial hard substrate habitat for offshore species.

Benthic Habitats and Sediment/Water Interface

Chemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.8.1 and 4.2.1.9.1)

These communities use a carbon source independent of photosynthesis and the sun-dependent photosynthetic food chain that supports all other life on earth. Although the process of chemosynthesis is entirely microbial, chemosynthetic bacteria can support thriving assemblages of higher organisms. This is accomplished through symbiotic relationships in which the chemosynthetic bacteria live within the tissues of tube worms and bivalves and provide a food source for their hosts. At least 69 communities are now known to exist in the Gulf (**Figure 4-8**).

Nonchemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.9.1 and 4.2.1.10.1)

Deepwater corals are relatively rare examples of deepwater communities that would not be expected considering the fact that the vast majority of the deep Gulf continental slope is made up of soft silt and clay sediments. Hermatypic (reef-building) corals contain photosynthetic algae and cannot live in deepwater environments; however, many ahermatypic corals can live on suitable substrates (hardgrounds) in these environments. Scleractinian corals are recognized in deepwater habitats, but there is little information regarding their distribution or abundance in the Gulf (USDOI, MMS, 2000, p. IV-14). Scleractinian corals may occupy isolated hard-bottom habitats but usually occur in association with high-density chemosynthetic communities that often are situated on carbonate hardgrounds.

Soft-Bottom Benthic Communities (Chapters 4.1.1.10.1 and 4.2.1.11.1)

Soft-bottom habitats consist primarily of sand/shell and are inhabited by different animals that may be classified as infauna and epifauna. These animals modify their habitats; also, some fishes modify these bottoms by burrowing.

Habitat Areas of Particular Concern

These are localized areas of EFH that are either ecologically important, sensitive, stressed, or a rare area as compared to with rest of a species EFH geological range. Examples of habitat areas of particular concern (HAPC's) as designated by Gulf of Mexico Fishery Management Council (GMFMC) are the Flower Garden Banks (West and East Flower Garden Banks, Stetson Bank, Rankin Bank, Bright Bank, 29 Fathom Bank, 28 Fathom Bank, MacNeil Bank, Geyer Bank, McGrail Bank, Sonnier Banks, Alderdice Bank, and Jakkula Bank), and in Florida there are Madison Swanson, Florida Middle Grounds, Pulley Ridge, and Tortugas Ecological Reserve. The NMFS has a poster outlining many of these banks, and it can be found at http://sero.nmfs.noaa.gov/hcd/pdfs/efhdocs/gom_efhhapc_poster.pdf.

D.4. FISHERIES (CHAPTERS 4.1.1.15, 4.1.1.16, 4.1.1.17, 4.2.1.18, 4.2.1.19, AND 4.2.1.20)

The Gulf is identified as EFH for species managed by the GMFMC and covered in the Shrimp Fishery Management Plan (FMP), Red Drum FMP, Reef Fish FMP, Spiny Lobster FMP, Coral and Coral Reef FMP, and Coastal Migratory Pelagic FMP. The highly migratory species managed by NOAA Fisheries (these species continue to have EFH designations extending in some cases to the Exclusive Economic Zone) also have EFH identified in the Gulf. Many of these species are of commercial importance and all of them spend a portion of their life cycle within the waters of the Gulf. The NMFS lists the species, EFH categories and designations, and HAPC in their *Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies; Gulf of Mexico Region* (USDOC, NMFS, 2010). The following is summarized from the Gulf of Mexico Fishery Management Council's *Final Environmental Impact Statement; Generic Essential Fish Habitat Amendment to the Following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, Red Drum Fishery of the Gulf of Mexico, Reef Fish Fishery of the Gulf of Mexico, Stone Crab Fishery of the Gulf of Mexico, Coral and Coral Reefs of the Gulf of Mexico, Spiny Lobster in the Gulf of Mexico and South Atlantic, Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic* (GMFMC, 2004) and the *Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat* (USDOC, NMFS, 2009). For the full list of species and their scientific names, see **Table D-1**.

Red Drum

Red drum utilize estuaries from Vermilion Bay, Louisiana to eastern Mobile Bay, Alabama, to 25 fathoms (46 m; 150 ft) in Florida and between Crystal River to Naples, Florida at 5-10 fathoms

(9-18 m; 30-60 ft) and Cape Sable, Florida, to the boundary of Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council. Red drum occur all over the Gulf from the estuaries to offshore 40 m (131 ft). They can tolerate wide salinity ranges. Red drum eggs are found nearshore and larvae are in estuaries in temperatures of 25° C (77° F), during the later summer and early fall. Larvae feed on copepods. Early juveniles utilize nearshore estuarine areas like bays in the early winter and eat a variety of prey. Adults are found from the estuaries to the continental shelf in the fall and are omnivores. Spawning occurs nearshore in the deeper waters by mouths of bays and inlets and the Gulf side of barrier islands in the fall.

Reef Fish

Reef fish utilize estuaries associated with the Gulf, occupy pelagic and benthic portions of the Gulf, and use different topographic features on the continental shelf with high relief and some soft bottoms (**Table D-2**). Different species and different life history stages use different parts of the Gulf.

Coastal Migratory Species

Coastal migratory species generally utilize estuaries. The habitat locations for these species can be found in **Table D-3**.

Shrimp

Shrimp generally spawn offshore, have demersal eggs and pelagic larvae that eat algae and zooplankton (**Table D-4**). Their post-larvae are found in estuaries and become benthic. The juveniles in estuaries and are omnivores and eventually emigrate offshore.

Spiny Lobster

These lobsters are found offshore associated with coral reefs and seagrass beds. Larvae eat plankton and when they move from offshore to inshore by bays and seagrass, they stop feeding. Juveniles utilize nearshore bays with macroalgae, sponges, and corals. They feed on invertebrates. Adults are found offshore associated with reefs, rocky habitat, and hard bottom, and they spawn offshore in reef fringes. They can be found in seagrass beds within bays and feed on invertebrates.

Corals

Coral larvae are planktonic. Corals are broadcast spawners and the primary locations of reed building are the Flower Garden Banks, Florida Middle Grounds, and the Dry Tortugas.

Highly Migratory Species

Highly Migratory Species' productivity varies with the Loop Current. General productivity in the Gulf is in different areas with different habitats; the highest fish resources are found in Mississippi River Delta, Florida Big Bend, Florida Middle Grounds, mid- and outer shelf, and De Soto Canyon (because it has upwelling). Highly Migratory Species occupy a range of habitats: estuaries, coastal, neritic, and offshore pelagic environments. **Tables D-5 and D-6** provide descriptions of where these species could be found in the Gulf of Mexico. In many of the statements, the states are used to help visualize approximately where in the Gulf the species could occur. The following information can be found in detail in USDOC, NMFS (2009). The NMFS has designated a vast area of the western Gulf of Mexico for Atlantic bluefin tuna as a HAPC; this species is found in both the Gulf of Mexico and the Atlantic Ocean (USDOC, NMFS, 2009). Smalltail shark, bigeye sixgill shark, sevengill shark, and sixgill shark do not have an EFH identified due to insufficient data.

Other Species of Importance

Mullets use coastal waters, estuaries, and rivers; they have wide salinity and depth (1-120 m; 3-393 ft) range. Their eggs are planktonic and are found offshore. Larvae are pelagic and migrate inshore by entering through estuaries, and they feed on zooplankton. Juveniles utilize estuaries and are found in the mud and sand, and they feed on detritus and algae. Adults are found in estuaries and rivers over mud and sand bottoms and with vegetation. They spawn during the fall and winter in offshore in large schools and return to the estuary after they spawn.

Gulf menhaden are estuarine dependent, pelagic, and schooling planktivores that occur at depth from 1-140 m (3-459 ft). Eggs are pelagic and are found both inshore and offshore. Larvae are passively transported into estuaries and associate with lower salinities. Juveniles are found in nonvegetated areas and move to more saline bays with size. Adults are found in nearshore waters in bays (<18 m; 59 ft) and spawn over the shelf in the fall and winter.

Blue crabs are found all over Gulf depending on the life history stage. Eggs are attached to females that occur in high salinity waters by barrier islands or bay mouths. Larvae (zoeae) are pelagic and are carried offshore to develop over the shelf. Post-larvae (megalope) migrate to estuaries and settle in vegetation and shoreline habitat; they are omnivores. Juveniles utilize vegetated habitats with mud and sand bottoms, and they have a wide salinity range. Adults are found in the same areas as juveniles, but females are generally found in higher salinities.

Oysters are found in inshore waters. Eggs sink and hatch. Larvae are free swimming until their foot forms and then they settle to the bottom on hard substrate; they are planktivorous. The oyster life cycle is all dependent on salinity cues. Adults grow attached to the substrate and are filter feeders and broadcast spawners. They release eggs and sperm during the spring to the fall in warm, high salinities waters (>10 practical salinity units).

D.5. IMPACTS OF ROUTINE OPERATIONS (CHAPTER 3.1)

Routine operations continue during the life of a lease, and different activities can have different effects on EFH. Generally, the activities would start with an exploration well and then delineation wells to find and help define the amount of resource or the extent of the reservoir (**Chapter 3.1.1.2.2**). Development wells are then drilled from movable structures, fixed bottom-supported structures, floating vertically moored structures, floating production facilities, and drillships (**Chapter 3.1.1.3.1**). Any drilling will cause some sort of bottom area disturbance (**Chapter 3.1.1.3.2.1**) and sediment displacement (**Chapter 3.1.1.3.2.2**). Most exploration drilling, platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, topside structures, or support vessels in place. Anchors disturb the seafloor and sediments in the area where dropped or emplaced (**Chapter 3.1.1.3.3.1**). Discharges are drilling muds and cuttings (**Chapter 3.1.1.4.1**), and produced waters (**Chapter 3.1.1.4.2**) will occur with production and development but they are highly regulated by USEPA. In order to move the vast amount of oil over the years, a mature pipeline network exists in the Gulf to transport oil and gas production from the OCS to shore (**Chapter 3.1.1.8.1**). Once a lease has expired, the lessee must 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 (**Chapter 3.1.1.10**). All of the routine operations are not all offshore. There are also coastal routine operations that can affect EFH, which include the following: service bases; gas processing plants; coastal pipelines; navigation channels; and disposal facilities for operations (discharge and wastewater) (**Chapters 3.1.2.1.1, 3.1.2.1.4.2**, **3.1.2.1.6**, **3.1.2.1.8, and 3.1.2.2**).

Water Column (Chapters 4.1.1.2.1.2, 4.1.1.2.2.2, 4.2.1.2.1.2, and 4.2.1.2.2.2)

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. During exploration activities, the primary impacting sources to offshore water quality are discharges of drilling fluids and cuttings. During platform and pipeline 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 service-vessel discharges, which might include water with an oil concentration of approximately 15 parts per million as established by regulatory standards. The USEPA and USCG regulations are in place to limit the toxicity of the ingredients, the levels of incidental contaminants in these discharges, and in some cases the discharge rates and discharge locations. 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 the impacts of these activities

Wetlands (Chapters 4.1.1.4.2 and 4.2.1.4.2)

Overall, the impacts to wetlands from routine activities associated with a WPA or CPA proposed action are expected to be low due to the small length of projected onshore pipelines, the minimal contribution from the small amount of maintenance dredging, and the State and COE mitigation measures that would be used to further reduce these impacts.

Seagrass Communities/Aquatic Macrophytes (Chapters 4.1.1.5.2 and 4.2.1.5.2)

Routine impacts from a WPA or CPA proposed action on submerged vegetation include dredging activities, pipeline route development, and prop scarring from vessel traffic. Because of Federal and State permit requirements and natural flushing (wind and current), any potential effects from routine activities on submerged vegetation are expected to be localized and not consequentially adverse.

Topographic Features (Chapters 4.1.1.6.2 and 4.2.1.7.2)

The Topographic Features Stipulation would prevent most of the potential impacts on topographic features from bottom-disturbing activities (structure removal and emplacement) and operational discharges associated with a WPA or CPA proposed action. Because of the No Activity Zone, BSEE 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.

Live Bottoms (Pinnacle Trend [Chapter 4.2.1.6.1.2] and Low Relief [Chapter 4.2.1.6.2.2])

Oil and gas operations discharge drilling muds and cuttings generate turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings in the Pinnacle Trend area would not greatly impact the biota of the live bottoms because the biota surrounding the pinnacle features are adapted to the turbid (nepheloid) conditions and high sedimentation rates associated with the outflow of the Mississippi River (Gittings et al., 1992). The pinnacles themselves are coated with a veneer of sediment. The toxicity of the produced waters has the potential to adversely impact the live-bottom organisms of the Pinnacle Trend; however, as previously stated, the Live Bottom (Pinnacle Trend) Stipulation would prevent the placement of oil and gas facilities upon (and consequently would prevent the discharge of produced water directly over) the Pinnacle Trend live-bottom areas.

The effects from routine operations would be similar to hard, low-relief live bottoms as they are to the pinnacle features. The toxicity of produced waters has the potential to adversely impact the live-bottom organisms; however, as previously stated, many of the low-relief areas are not in the area to be offered in a CPA proposed action and the proposed Live Bottom (Low Relief) Stipulation would prevent the placement of oil and gas facilities upon (and consequently would prevent the discharge of produced water directly over) low-relief, live-bottom habitats. Produced waters also rapidly disperse and remain in the surface layers of the water column, far above the live-bottom features.

Sargassum (Chapters 4.1.1.7.2 and 4.2.1.8.2)

All types of discharges, including drill muds and cuttings, produced water, and operational discharges (e.g., deck runoff, bilge water, and sanitary effluent), would contact a small portion of the *Sargassum* algae. Routine operations of a WPA or CPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community as a whole. The *Sargassum* community occupies 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.

Chemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.8.2 and 4.2.1.9.2)

Chemosynthetic communities are susceptible to physical impacts from anchoring, structure emplacement, pipeline installation, structure removal, and drilling discharges. The guidance described in NTL 2009-G40 greatly reduces the risk of these physical impacts by requiring the avoidance of potential chemosynthetic communities. Routine operations of a WPA or 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 oil and gas activities in deep water because the impacts would be limited by standard BOEMRE protections in place as described in NTL 2009-G40.

Nonchemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.9.2 and 4.2.1.10.2)

Some impact to deepwater benthic communities from drilling and production activities would occur as a result of physical impacts and drilling discharges regardless of their locations. However, recolonization of populations from widespread neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms. Widely scattered, deep live bottoms would not be expected to experience impacts from routine oil and gas activities in deep water because the impacts would be limited by standard BOEMRE protections in place as described in NTL 2009-G40.

Soft-Bottom Benthic Communities (Chapters 4.1.1.10.2 and 4.2.1.11.2)

Although localized impacts to comparatively small areas of the soft-bottom benthic habitats would occur, the impacts would be on a relatively small area of the seafloor compared with the overall area of the seafloor (384,567 km^2; 148,482 mi^2). The greatest impact is the alteration of benthic communities as a result of smothering, chemical toxicity, and substrate change. Communities that are smothered by cuttings repopulate, and populations that are eliminated as a result of sediment toxicity or organic enrichment would be taken over by more tolerant species. The community alterations are a shift in species dominance (Montagna and Harper, 1996). These localized impacts generally occur within a few hundred meters of platforms, and the greatest impacts are seen close to the platform. These patchy habitats within the Gulf are probably not different from the early successional communities that predominate throughout areas of the Gulf that are frequently disturbed (Gaston et al., 1998; Diaz and Solow, 1999; Rabalais et al., 2002).

Fish Resources (Chapters 4.1.1.15.2 and 4.2.1.18.2)

Effects on fish resources from routine activities associated with a WPA or CPA proposed action could result from coastal environmental degradation, marine environmental degradation, pipeline trenching, and offshore discharges of drilling muds and produced waters. Some of the routine impact-producing factors are mitigated by BOEM through the Topographic Feature and the Live Bottom (Pinnacle Trend/Low Relief) Stipulations, which are described in NTL 2009-G39. The NTL 2009-G39 and NTL 2009-G40 advise operators to avoid hard-bottom habitats that support fish populations. Much of the coastal wetland loss that supports estuarine habitat and nursery grounds, upon which fish stocks are dependent, is a result of inshore oil and gas extraction and not the result of offshore oil and gas leasing. The Gulf of Mexico fish stocks have retained both diversity and biomass throughout the years of offshore development, and a WPA or CPA proposed action is expected to result in a minimal decrease in fish resources and/or standing stocks.

D.6. IMPACTS OF ACCIDENTAL EVENTS

Offshore oil spills and their probabilities are presented in **Chapter 3.2.1.5** for a spill ≥1,000 bbl and in **Chapter 3.2.1.6** for a spill <1,000 bbl. Coastal spills are analyzed in **Chapter 3.2.1.7**, and the response activities for the spills are discussed in detail in **Chapter 3.2.1.9**. This is a summary of the effects of these spills on EFH. There is also a summary of the effects of a catastrophic spill on each EFH.

Water Column (Chapters 4.1.1.2.1.3, 4.1.1.2.2.3, 4.2.1.2.1.3, and 4.2.1.2.2.3)

Accidental events associated with a WPA or CPA proposed action that could impact coastal and 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 could also result in such spills. The usage of chemical dispersants in oil-spill response could be associated with accidental events and could have impacts to water quality. Although response efforts may decrease the amount of oil in the environment, the response efforts may also impact the environment. Natural degradation processes would also decrease the amount of spilled 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. Over time, natural processes can physically, chemically, and biologically degrade oil. Chemicals used in the oil and gas industry are not a significant risk in the event of a spill. This is 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 so infrequently.

Wetlands (Chapters 4.1.1.4.3 and 4.2.1.4.3)

Overall, impacts to wetland habitats from an oil spill associated with activities related to a WPA or CPA proposed action would be expected to be low and temporary. This is because of the dynamic nature of the system, State and COE permit regulations, and specific cleanup techniques. Coastal spills would be localized and have a quick response, which would decrease the amount of wetlands affected.

Seagrass Communities/Aquatic Macrophytes (Chapters 4.1.1.5.3 and 4.2.1.5.3)

The floating nature of nondispersed crude oil, the regional microtidal range, dynamic climate with mild temperatures, and the amount of microorganisms that consume oil would alleviate prolonged effects on submerged vegetation communities. Also, safety and spill-prevention technologies continue to improve and will decrease detrimental effects to submerged vegetation from a WPA or CPA proposed action.

Topographic Features (Chapters 4.1.1.6.3 and 4.2.1.7.3)

The Topographic Features Stipulation 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. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, 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 topographic features were reached, also resulting in sublethal impacts. Impacts from an oil spill on topographic features are also lessened by the distance of the spill, the depth, and the currents that surround the topographic features.

Live Bottoms (Pinnacle Trend [Chapter 4.2.1.6.1.3] and Low Relief [Chapter 4.2.1.6.2.3])

Live-bottom (Pinnacle Trend) features represent a small fraction of the continental shelf area. The small portion of the seafloor covered by these features, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to the Pinnacle Trend features. The Live Bottom (Pinnacle Trend) Stipulation would prevent most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of Pinnacle Trend features. However, operations outside the proposed buffer zones around sensitive habitats (including blowouts and oil spills) may affect live-bottom features.

The depth (≥ 60m; 200 ft) below the sea surface where the Pinnacle Trend is located helps to protect it from surface oil spills. 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.

The limited relief of many live bottom features helps to protect them from surface oil spills. 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.

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. Sedimented oil or sedimentation as a result of a blowout may impact benthic organisms. Impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. The Live Bottom (Pinnacle Trend) and Live Bottom (Low Relief) Stipulations would limit the potential impact of occurrences such as blowouts, surface, and subsurface oil spills and the associated effects by keeping the sources of such adverse events geographically removed from the sensitive biological resources of live-bottom features. Because of the distance from live bottoms, sedimented oil should be well dispersed, resulting in a light layer of deposition that would be easily removed by the organism and have low toxicity.

Sargassum (Chapter 4.1.1.7.3 and 4.2.1.8.3)

The *Sargassum* community occupies the pelagic waters in areas with generally high water quality and is expected to show good resilience to the predicted effects of spills. It has a yearly cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community unless a catastrophic spill occurs.

Chemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.8.3 and 4.2.1.9.3)

Most accidental events associated with a WPA or CPA proposed action would result in only minimal impacts to chemosynthetic communities with adherence to the biological stipulation and the guidelines described in NTL 2009-G40. One exception would be in the case of a catastrophic spill combined with the application of dispersant, 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.

Nonchemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.9.3 and 4.2.1.10.3)

Accidental events associated with a WPA or CPA proposed action would result in only minimal impacts to nonchemosynthetic communities with adherence to the biological stipulation and the guidelines described in NTL 2009-G40. One exception would be in the case of a catastrophic spill combined with the application of dispersant, 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.

Soft-Bottom Benthic Communities (Chapters 4.1.1.10.3 and 4.2.1.11.3)

Because of the small amount of proportional space that OCS activities occupy on the seafloor, only a small portion of the seafloor of the Gulf would experience lethal impacts as a result of blowouts, surface and subsurface oil spills, and the associated effects. The greatest impacts would be closest to the spill site, 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 would prevent contact with concentrated oil. Any sedimentation, sedimented oil, and oil from a subsurface spill that reaches benthic communities would be at low concentrations by the time it reached the benthic communities and be primarily sublethal so impacts would be at the local community level. 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 an extremely small portion of the overall Gulf of Mexico.

Fish Resources (Chapters 4.1.1.15.3 and 4.2.1.18.3)

Accidental events that could impact fish resources include blowouts and oil or chemical spills. Because subsurface blowouts, although a highly unlikely occurrence, suspend large amounts of sediment, they have the potential to adversely affect fish resources in the immediate area of the blowout. If oil spills due to a WPA or CPA proposed action were to occur in open waters of the OCS proximate to mobile adult fish, 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. Fish populations may be impacted by an oil spill but they would be primarily affected if the oil reaches the shelf and estuarine areas, because these are the most productive areas, but the probability of a spill in these areas is low. 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. A WPA or CPA proposed action is not expected to significantly affect fish populations in the Gulf of Mexico.

D.7. IMPACTS OF A CATASTROPHIC SPILL EVENT (APPENDIX B)

Water Column

During the initial phase of a catastrophic blowout, water quality impacts include disturbance of sediments and the release and suspension of oil and natural gas (methane) into the water column. Some sediment could travel several kilometers, depending on particle size and subsea current patterns. In the deep Gulf, surficial sediments are mostly composed of silt and clay and, if resuspended, could stay in the water column for several hours to even days. 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). Dispersed hydrocarbons may adsorb onto marine detritus (marine snow) or may be mixed with drilling mud and deposited near the source. A catastrophic blowout also 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. 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 (e.g., increased vessel traffic and the addition of dispersants and methanol to the marine environment). The temporary decrease in oxygen content has been attributed to microbial degradation of the oil. Over time, as the oil continues to be degraded and diffuses, hypoxia becomes less of a concern.

Methane may stay in the marine environment for long periods of time (Patin, 1999; p. 237), and methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974; p. 23). Methane and other natural gas constituents are carbon sources, and their introduction into the marine environment could also result in reducing the dissolved oxygen levels due to microbial degradation of the methane, potentially creating hypoxic or "dead" zones. These areas also decrease in time as methane/natural gas constituents degrade.

Wetlands

Previous studies of other large spills have shown that, when oil has a short residence time in the marsh and is not incorporated into the sediments, the marsh vegetation has a good chance of survival. This is true even if aboveground die-off of marsh vegetation occurs (Lin et al., 2002). However, if reoiling occurs and the new shoots are killed, then the marsh plants may not have enough stored energy to produce a second round of new shoots. 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. This is because of the response procedures implemented during a catastrophic spill. If the duration is long and the magnitude is great, then 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.

Seagrass Communities/Aquatic Macrophytes

If coastal waters, bays, and estuaries accrue oil, there is an assumption that there would be a decrease in local submerged vegetation cover and negative community impacts. Depending on the species and environmental factors, seagrasses may exhibit minimal impacts from a spill; however, the communities within the beds could accrue greater negative outcomes (Jackson et al., 1989; Taylor et al., 2006). Community effects could range from either direct mortality due to smothering or indirect mortality from loss of food sources and loss of habitat due to a decrease in ecological performance of the entire system (Zieman et al., 1984).

Hard Bottoms (Topographic Features and Live Bottoms/Low Relief)

Impacts that occur to hard-bottom shelf habitats 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). If the blowout were to occur beneath the seabed, suspension and subsequent deposition of disturbed sediment may smother localized areas of benthic and live bottom communities. This could possibly include organisms within No Activity Zones or other hard-bottom substrate. Sediment from a blowout, if it occurred nearby, may have a reduced impact on these communities compared with an open-water reef community. This is because these hard-bottom organisms are more tolerant of suspended sediment (Gittings et al., 1992). 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. Low-level exposures of corals to oil from a subsea plume may result in chronic or temporary impacts. Corals exposed to subsea oil plumes may incorporate petroleum hydrocarbons into their tissue. Reductions in feeding and photosynthesis are some impacts that may occur to coral exposed to dispersed oil. Dispersed oil does appear to be more toxic to coral species than oil or dispersant alone. Both hard and soft corals have the ability to produce mucus. Mucus production has been shown to increase when corals are exposed to crude oil, and this mucus can protect the organisms from oil (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Vessel anchorage and decontamination stations set up during response efforts may also break or kill hard-bottom features.

Sargassum

Free-floating patches of *Sargassum* and spilled oil tend to accumulate in convergence zones. Many species, including fish and invertebrates, use *Sargassum* for food and cover (Dooley, 1972; Stoner, 1983; Coston-Clements et al., 1991). Burn operations sometime occur in areas with high cover of *Sargassum* because of the associated aggregated oil (Unified Incident Command, 2010). This is because oceanographic processes that concentrate *Sargassum* into mats and rafts would also concentrate toxic substances within those flotsam. Therefore, it may be assumed that *Sargassum* would be found in areas where oil, dispersants, and other chemicals have accumulated following a catastrophic spill. This accumulation in the *Sargassum* creates a toxic environment for associated species, especially those that use the *Sargassum* as refuge for larvae or other developmental stages (Unified Incident Command, 2010).

Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities

There is a possibility that a well could be drilled close enough for a chemosynthetic or nonchemosynthetic community to be damaged in the event of a catastrophic blowout. Blowouts at points above the seafloor (in the riser or on the drill platform) would have little immediate effect on deepwater seafloor communities unless the structure sinks and physically impacts the seafloor. Many invertebrates associated with chemosynthetic or nonchemosynthetic communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure. 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.

Soft-Bottom Benthic Communities

When soft-bottom infaunal communities are physically impacted by a blowout (either lost to the crater formation or smothered by sediment), recolonization by populations from neighboring soft-bottom substrate is expected within a relatively short period of time. This is 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. A slow recovery rate will result in a community with reduced biological diversity and possibly a lesser food value for predatory species, which would decrease the value of the soft-bottom community as EFH. Many of the organisms on soft bottoms live within the sediment and have the ability to migrate upward in response to burial by sedimentation. 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. 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. Therefore, the soft bottom that is expected to suffer greatest effects would be soft bottoms in the immediate vicinity of a seafloor blowout in which some oil is mixed into the sediment.

Fish Resources

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. 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. Early life stages of animals are usually more sensitive to oil than adults (Boesch and Rabalais, 1987; NRC, 2005). 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). Therefore, if a catastrophic blowout occurs in the spring and summer seasons, it could cause greater harm to fish populations.

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 because this would expose the dispersed oil throughout the water column. The USEPA used standard *in vitro* techniques using the same dispersants to (1) evaluate acute toxicity on three cell lines over a range of concentrations and (2) evaluate effects of these dispersants on androgen and estrogen function using human cell lines (to see if they are likely to disrupt hormonal systems) (USEPA, Office of Research and Development, 2010). Results of the *in vitro* toxicity tests were similar to the whole animal tests, showing generally low dispersant toxicity (USEPA, Office of Research and Development, 2010).

D.8. CUMULATIVE IMPACTS

The OCS Program (**Chapter 3.3.1**) along with State oil and gas activities (**Chapter 3.3.2**) and other offshore activities including dredging and artificial reefs (**Chapters 3.3.3.1 and 3.3.3.5**) will continue to affect offshore EFH. Coastal cumulative effects on EFH include submerged wetlands, river development and flood controls, and dredging events (**Chapters 3.4.4.1, 3.3.4.2, and 3.3.4.3**), and these will affect EFH. Natural disturbances (**Chapter 3.3.7**) such as tropical cyclones will continue to be a presence and affect EFH as well.

Water Column (Chapters 4.1.1.2.1.4, 4.1.1.2.2.4, 4.2.1.2.1.4, and 4.2.1.2.2.4)

Water quality in coastal and offshore 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. Natural seeps and discharges from exploration and production activities are other potential impacting factors to offshore waters. The effects on water quality resulting from a WPA or CPA proposed action are a small addition to the cumulative impacts (other Federal agencies, States, private vessels, increases in human population, and natural events or processes) on the waters of the Gulf. Increased turbidity and discharge from a WPA or CPA proposed action would be temporary in nature and minimized by Federal permit regulations and mitigation. Since a catastrophic accident is considered rare and not expected to occur in coastal waters, the impact of accidental spills is expected to be small. In offshore waters, 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 (NRC, 2003). The effect on coastal water quality from smaller accidental spills is expected to be minimal relative to the cumulative inputs of hydrocarbons from other sources. The incremental contribution of the routine activities and accidental events associated with a WPA or CPA proposed action to the cumulative impacts on coastal and offshore water quality is not expected to be significant as long as all regulations are followed.

Wetlands (Chapters 4.1.1.4.4 and 4.2.1.4.4)

Wetlands are most vulnerable to inshore or nearshore oil spills but such spills are generally localized events. Spill sources include vessel collisions, pipeline breaks, and shore-based transfer, refining, and production facilities. There is a reduced risk of spills contacting wetlands because of the distance of offshore facilities to wetland sites, beach and barrier island topography (although locally reduced post-Hurricanes Katrina and Rita), and product transportation through existing pipelines or pipeline corridors. If oil reaches wetlands, only light localized impacts to inland wetlands would occur.

While landloss will continue from subsidence and saltwater intrusion, the State of Louisiana and COE have implemented freshwater diversion projects to minimize the effect of this saltwater-induced landloss. This would cause a change in the type of EFH (i.e., wetlands to open water). A WPA or CPA proposed action would not require any channel maintenance; therefore, no additional wetland loss would result from dredged material disposal. If dredged-material disposal is required, it would likely be beneficially used for marsh creation. Though existing pipeline channels are estimated to continue to erode wetlands, estimates do not take into account the current regulatory programs, and modern construction techniques and COE mitigations. Because of modern construction techniques and mitigation measures, there would be zero to negligible impacts on wetland habitats as a result of a WPA or CPA proposed action.

The disposal of OCS wastes and drilling by-products would be delivered to existing facilities. Because of existing capacity, no additional expansion into wetland areas is expected. Development pressures in the coastal regions of Texas, 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, and commercial developments have caused the most destruction of wetlands in Mississippi, Alabama, and Florida. In Texas and Florida, recreational and tourist developments have been particularly destructive. These trends are expected to continue.

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. The incremental contribution of a WPA or CPA proposed action to the cumulative impacts on coastal wetlands is expected to be small.

Seagrass Communities/Aquatic Macrophytes (Chapters 4.1.1.5.4 and 4.2.1.5.4)

Dredging generates the greatest overall risk to submerged vegetation, while naturally occurring hurricanes cause direct damage to beds. The Federal and State permit mitigation policies that are currently in place, the small probability of an oil spill, and the natural flow regimes of coastal waters are not expected to change in the near future. These activities further reduce the incremental contribution of stress from a WPA or CPA proposed action on submerged vegetation.

Topographic Features (Chapters 4.1.1.6.4 and 4.2.1.7.4)

Activities causing mechanical disturbance represent the greatest threat to the topographic features. Potential OCS-related impacts include the anchoring of vessels and structure emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal. This would be prevented by the continued application of the proposed Topographic Features Stipulation. As such, little impact would be incurred by the biota of the topographic features. The USEPA discharge regulations and permits would further reduce any discharge-related impacts.

If a subsea oil plume is formed, it could contact the habitats of a topographic feature; this contact may be restricted to the lower, less sensitive levels of the banks and/or may be swept around the banks with the prevailing water currents. The farther the oil source is from the bank, the more dilute and degraded the oil would be when it reaches the vicinity of the topographic features.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The proposed Topographic Features Stipulation would keep sources of OCS spills at least 152 m (500 ft) away from the immediate biota of the topographic features. The majority of oil released below the sea surface rises 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 the very unlikely event that oil from a subsurface spill reached an area containing hermatypic coral cover 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-related activities sank and proceeded to collide with the topographic features or associated habitat releasing its cargo, 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 activities could mechanically disrupt the bottom (such as anchoring 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, ocean dumping, and discharges or spills from tankering of imported oil could have detrimental effects on topographic features.

Overall, the incremental contribution of a WPA or CPA proposed action to the cumulative impact is negligible because of the implementation of the proposed Topographic Features Stipulation, which would limit mechanical impacts and operational discharges.

Live Bottoms (Pinnacle Trend [Chapter 4.2.1.6.1.4] and Low Relief [Chapter 4.2.1.6.2.4])

Non-OCS activities that may occur in the vicinity of the pinnacle and hard bottom, low relief communities include recreational boating and fishing, import tankering, fishing and trawling, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions. These activities could cause damage to the live bottom communities. Ships using fairways in the vicinity of communities anchor in the general area of live bottoms on occasion, and numerous fishermen take advantage of the resources of regional bottoms. These activities could lead to instances of severe and permanent physical damage to individual formations. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments (Brooks, 1991; CSA, 1992). Because of the depth of the Pinnacle Trend area, these forces are not expected to be strong enough to cause direct physical damage to organisms living on those reefs. Yearly hypoxic events may affect portions of live-bottom benthic populations in the northeast part of the CPA (Rabalais et al., 2002).

Possible impacts from OCS oil and gas routine operations include anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, and discharges of produced waters. In addition, accidental subsea oil spills, or blowouts associated with OCS activities can cause damage to pinnacle communities. Long-term OCS activities are not expected to adversely impact the live-bottom environment because these impact-producing factors are restrained by the continued implementation of the lease stipulation and site-specific mitigations. The inclusion of the Live Bottom (Pinnacle Trend) and Live Bottom (Low Relief) Stipulations would preclude the occurrence of physical damage, the most potentially damaging of these activities. The impacts to the live bottoms are judged to be infrequent because of the small number of operations in the vicinity of pinnacles and other hard, live bottoms and the distance of these operations from the habitats. The impact to the live/hard-bottom resource as a whole is expected to be minimal because of primarily localized impacts. Potential impacts from discharges would be further reduced by USEPA discharge regulations and permits restrictions.

The incremental contribution of a WPA or CPA proposed action to the cumulative impact is expected to be minimal, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts should be restricted by the implementation of the Live Bottom (Pinnacle Trend) and Live Bottom (Low Relief) Stipulations, the fact BOEM is not currently offering the low-relief habitats for lease, and the distance of live-bottom habitats from the source of OCS-related impacts.

Sargassum (Chapters 4.1.1.7.4 and 4.2.1.8.4)

Because of the ephemeral nature of *Sargassum* communities, many activities associated with a WPA or CPA proposed action would have a localized and short-term effect. There is also a low probability that a catastrophic spill would occur with a WPA or CPA proposed action. The incremental contribution of a proposed action to the overall cumulative impacts on *Sargassum* communities that would result from the OCS Program, environmental factors, and non-OCS-related user group activities are expected to be minimal.

Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.8.4, 4.1.1.9.4, 4.2.1.9.4, and 4.2.1.10.4)

Cumulative impacts to deepwater communities in the Gulf from sources other than OCS activities are considered negligible. The most serious, impact-producing factor threatening chemosynthetic and nonchemosynthetic communities is physical disturbance of the seafloor, including activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. These could destroy the organisms of these communities. 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 Gulf. Guidance provided in NTL 2009-G40 describes required surveys and avoidance prior to drilling or pipeline installation and would greatly reduce risk. Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths in these areas (>300 m; 984 ft) and the low density of potentially commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes. Regionwide and even global impacts from CO_2 build-up and proposed methods to sequester carbon in the deep sea (e.g., ocean fertilization) are not expected to have major impacts to deepwater habitats in the near future.

The proposed activities considered under the cumulative scenario are expected to cause no damage to the ecological function or biological productivity of widespread, low-density deepwater communities. The rarer, widely scattered, high-density communities could experience isolated minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years, but even minor impacts are not expected. There is evidence that substantial impacts on these communities could permanently prevent reestablishment. Other sublethal impacts 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. Adverse impacts from a WPA or CPA proposed action would be limited but not completely eliminated by adherence to the requirements described in NTL 2009-G40.

Soft-Bottom Benthic Communities (Chapters 4.1.1.10.4 and 4.2.1.11.4)

Non-OCS activities that may occur on soft-bottom benthic substrate include recreational boating and fishing, import tankering, 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 may crush and smother underlying organisms. Damage resulting from commercial fishing, especially bottom trawling, may have a severe impact on soft-bottom benthic communities. Oil spills from non-OCS import tankering or other activity may result in oiled benthic communities that will only repopulate once the concentration of oil in the sediment has decreased. During severe storms, 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 (Dobbs and Vozarik, 1983; Engle et al., 2008). 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., 2002).

Impacts from routine activities of OCS oil and gas operations include anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, and discharges of produced waters. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to infaunal communities. Long-term OCS 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. The USEPA's general NPDES permit restrictions on the discharge of produced water would help to limit the impacts on benthic communities (Smith, 1994).

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals may have local devastating impacts but the cumulative effect on the overall seafloor and infaunal communities on the Gulf would be very small. Soft-bottom benthic communities are ubiquitous throughout and often remain in an early successional stage due to natural fluctuation, and therefore, the activities of OCS production of oil and gas would not cause additional severe cumulative impacts.

The incremental contribution of a WPA or 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.

Fish Resources (Chapters 4.1.1.15.4 and 4.2.1.18.4)

The OCS factors potentially impacting fish resources in the Gulf of Mexico are federally regulated or mitigated and small. There are many anthropogenic factors regulated by Federal and State agencies and natural factors that cannot be regulated. Also to be considered is the variability in Gulf fish populations due to natural factors such as spawning success and juvenile survival. Overall, the incremental contribution of the OCS effects to fish populations is small.

Overfishing (including bycatch) has contributed in a large way to some populations of Gulf fish. The Magnuson-Stevens Act and its amendments address sustainable fisheries and set guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities. Limits on catch and fishing seasons are set by the GMFMC. State agencies regulate inshore fishing seasons and limits.

Naturally occurring tropical cyclones can cause damage to various EFH's. These can be onshore as with wetland loss and offshore with damaged topographic features. These storms are a continual part of the Gulf of Mexico climate.

All of these events and activities cause some sort of effect on the different EFH's and fish resources. Many anthropogenic inputs, including a WPA or CPA proposed action, are now monitored, regulated, and mitigated by the permitting agency or State. These efforts will continue in the future, and the restoration of habitats could increase with better technologies. While EFH and fish resources are impacted by these many factors, a WPA or CPA proposed action would add a minimal amount to the overall cumulative effects.

D.9. OVERALL GENERAL CONCLUSIONS

Water Column

There is little chance of irreversible impacts to the water column from a WPA or CPA proposed action. The USEPA and USCG regulations are in place to limit the toxicity of the ingredients, the levels of incidental contaminants in these discharges, and in some cases the discharge rates and discharge locations. Natural degradation processes would also decrease the amount of spilled oil over time. The effects on water quality resulting from a WPA or CPA proposed action are a small addition to the cumulative impacts (i.e., other Federal agencies, States, private vessels, increases in human population, and natural events or processes) on the waters of the Gulf. In offshore waters, 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 (NRC, 2003).

Wetlands and Seagrass Communities/Aquatic Macrophytes

A loss of wetlands and associated biological resources (including submerged grass beds) could occur if these vegetated habitats 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-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 absence of new sediment added to the delta plain appear to be much more dominant processes impacting coastal wetlands. These losses would actually be changes in EFH from flooded vegetated habitat to open-water habitats.

Sensitive Nearshore and Offshore Biological Resources

An irreversible loss or degradation of ecological habitat caused by cumulative activity from a WPA or CPA proposed action 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.

Fish Resources and Commercial Fisheries

The largest impacts to these resources from a WPA or CPA proposed action would be the 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. Structure removal 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. However, when compared with the other EFH's in the Gulf, these structures are a small amount of habitat.

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Table D-1

Managed Species in the Gulf of Mexico

Red Drum Fishery red drum (*Sciaenops ocellatus*) **Reef Fish Fishery** blackfin snapper (*Lutjanus buccanella*) cubera snapper (*Lutjanus cyanopterus*) gray snapper (*Lutjanus griseus*) lane snapper (*Lutjanus synagris*) mutton snapper (*Lutjanus analis*) queen snapper (*Etelis oculatus*) red snapper (*Lutjanus campechanus*) silk snapper (*Lutjanus vivanus*) vermilion snapper (*Rhomboplites aurorubens*) yellowtail snapper (*Ocyurus chrysurus*) wenchman (*Pristipomoides aquilonaris*) black grouper (*Mycteroperca bonaci*) gag (*Mycteroperca microlepis*) Nassau grouper (*Epinephelus striatus*) red grouper (*Epinephelus morio*) scamp (*Mycteroperca phenax*) speckled hind (*Epinephelus drummondhayi*) snowy grouper (*Epinephelus niveatus*) yellowedge grouper (*Epinephelus flavolimbatus*) yellowfin grouper (*Mycteroperca venenosa*) yellowmouth grouper (*Mycteroperca interstitialis*) greater amberjack (*Seriola dumerili*) lesser amberjack (*Seriola fasciata*) almaco jack (*Seriola rivoliana*) banded rudderfish (*Seriola zonata*) gray triggerfish (*Balistes capriscus*) goldface tilefish (*Caulolatilus chrysops*) tilefish (*Lopholatilus chamaeleonticeps*) hogfish (*Lachnolaimus maximus*) **Coastal Migratory Pelagic Fishes** cobia (*Rachycentron canadum*) king mackerel (*Scomberomorus cavalla*) Spanish mackerel (*Scomberomorus maculatus*)	**Corals** Class Hydrozoa (stinging and hydrocorals) Class Anthozoa (sea fans, whips, precious coral, sea pen, stony corals) **Shrimp Fishery** brown shrimp (*Farfantepenaeus aztecus*) pink shrimp (*Farfantepenaeus duorarum*) royal red shrimp (*Pleoticus robustus*) white shrimp (*Litopenaeus setiferus*) **Spiny Lobster Fishery** spiny lobsters (*Panulirus argus*) **Highly Migratory Species** albacore (*Thunnus alalunga*) Atlantic bluefin tuna (*Thunnus thynnus*) Atlantic bigeye tuna (*Thunnus obesus*) Atlantic yellowfin tuna (*Thunnus albacares*) skipjack (Katsuwonus *pelamis*) swordfish (*Xiphias gladius*) blue marlin (*Makaira nigricans*) sailfish (*Istiophorus platypterus*) white marlin (*Tetrapturus albidus*) longbill spearfish (*Tetrapturus pfluegeri*) basking shark (*Cetorhinus maximus*) great hammerhead (*Sphyrna mokarran*) scalloped hammerhead (*Sphyrna lewini*) smooth hammerhead (*Sphyrna zygaena*) white shark (*Carcharodon carcharias*) nurse chark (*Ginglymostoma cirratum*) bignose shark (*Carcharhinus altimus*) blacktip shark (*Carcharhinus limbatus*) bull shark (*Carcharhinus leucas*) Caribbean reef shark (*Carcharhinus perezi*) dusky shark (*Carcharhinus obscurus*) Galapagos shark (*Carcharhinus galapagensis*) lemon shark (*Negaprion brevirostris*) narrowtooth shark (*Carcharhinus brachyurus*) night shark (*Carcharhinus signatus*) sandbar shark (*Carcharhinus plumbeus*)

Table D-1. Managed Species in the Gulf of Mexico (continued).

Highly Migratory Species (continued)	**Highly Migratory Species (continued)**
silky shark (*Carcharhinus falciformis*)	finetooth shark (*Carcharhinus isodon*)
spinner shark (*Carcharhinus brevipinna*)	smalltail shark (*Carcharhinus porosus*)
tiger shark (*Galeocerdo cuvieri*)	bigeye sixgill shark (*Hexanchus vitulus*)
bigeye sand shark (*Odontaspis noronhai*)	sevengill shark (*Heptranchias perlo*)
sand tiger shark (*Odontaspis taurus*)	sixgill shark (*Heptranchias griseus*)
whale shark (*Rhinocodon typus*)	longfin mako shark (*Isurus paucus*)
Atlantic angel shark (*Squatina dumerili*)	shortfin mako shark (*Isurus oxyrinchus*)
bonnethead shark (*Sphyrna tiburo*)	blue shark (*Prionace glauca*)
Atlantic sharpnose (*Rhinocodon terraenovae*)	oceanic whitetip shark (*Carcharhinus longimanu*)
blacknose shark (*Carcharhinus acronotus*)	bigeye thresher shark (*Alopias superciliosus*)
Caribbean sharpnose shark (*Rhinocodon porosus*)	common thresher shark (*Alopias vulpinus*)

Sources: GMFMC, 2004.
USDOC, NMFS, 2010.

Table D-2

Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Grey trigger	Sand bottoms near reef habitats in the spring and summer seasons		Upper water column in spring and summer seasons	Upper water column associated with *Sargassum* and eat from *Sargassum*	Continental shelf waters (>10 m; 33 ft), reefs in the late spring and summer, and eat invertebrates
Greater amberjack	Gulfwide	Gulfwide	Offshore in the summer	Gulfwide with floating structures (*Sargassum*) in the late summer and fall and feed on invertebrates	Gulfwide near the structured habitat, eat invertebrates and fishes, and spawn in the spring and summer offshore
Lesser amberjack	Gulfwide	Gulfwide		Gulfwide; associated with floating structures (*Sargassum*) in the late summer and fall and feed on invertebrates	Gulfwide; near the bottom, associated with structures, feed on squid, and spawn in spring and fall
Almaco jack	Gulfwide	Gulfwide		Gulfwide; associated with floating structures (*Sargassum*) and barrier islands in the late summer and fall, and feed on invertebrates	Southern Gulf, offshore associated with platforms, prey on fishes, and spawning is hypothesized to be spring and fall
Banded rudderfish		Gulf Stream every other month (starting with January)		Offshore, associated with floating structures (*Sargassum*), year round	Coastal waters over the continental shelf, both pelagic and epibenthic; feed on fish and shrimp, and spawn year round offshore
Hogfish				Seagrass beds of Florida Bay and eat invertebrates	Coral reefs and rocky flats, and eat mollusks

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Queen snapper	Offshore	Offshore			Deep water in southern Gulf (>100 m; 328 ft) in rocky bottoms; eat fish, crustaceans, and squid; and spawn in March and August in St. Lucia
Mutton snapper	Shallow continental shelf waters	Shallow continental shelf waters		Seagrasses during the summer	Seagrass or reefs, year round, eat nekton, and spawn in south Florida at drop offs near coral reefs in late springs
Blackfin snapper	Continental shelf year round			Shallow waters with hard substrate (12-40 m; 39-131 ft) by the Virgin Islands in spring	Continental shelf edge, eat nekton, and spawn year round
Red snapper	Offshore in the summer and fall	Continental shelf waters in summer and fall, and eat rotifers and algae		Continental shelf associated with structures and feed on zooplankton and shrimp	Hard and irregular bottoms, eat nekton, and spawn offshore away from coral reefs in sand bottoms with low relief in summer and fall
Cubera snapper	Near coral reefs and wrecks of medium depth (80 m; 262 ft) in the summer			Shallow vegetated waters in estuaries near streams and rivers wide salinity ranges	Southern Gulf near reefs and mangroves, in wide salinity ranges, eat nekton, and spawn in the Florida Keys at approximately 80 m (262 ft)
Gray snapper	High salinity continental shelf waters near coral reefs in the summer	High salinity continental shelf waters near coral reefs in the summer and eat zooplankton	Move to estuaries with vegetation (seagrass), wide salinity and temperature ranges, and eat copepods and amphipods	Feed on crustaceans	Onshore and offshore, eat nekton, and spawn offshore near reefs in summer

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Lane snapper	Continental shelf and offshore in the summer			Low salinity inshore grasses, coral reefs, and soft bottoms (0-20m; 0-65 ft), and eat small invertebrates	High salinity offshore waters in sand bottoms with structure; wide depth range of 4-130 m (13-426 ft); eat nekton, annelids, and algae; spawning peak offshore in midsummer
Silk snapper	Shallow water year round and eat nekton	Shallow water year round and eat nekton		Shallow water year round and eat nekton	Edge of the continental shelf (90-140 m; 295-459 ft), ascend at night, feed on nekton, and spawn year round (more so in the late summer)
Yellowtail snapper	Found in February and October	Shallow water with vegetation and structure and feed on zooplankton		Nearshore with vegetation and move to shallow coral reefs with age	Semipelagic and use deeper coral reefs (50 m; 164 ft), feed on nekton, and spawn away from shore with peaks in February-April and September-October
Vermilion snapper				Coral reefs and rocky bottoms (20-200 m; 65-656 ft), spawn offshore in spring-summer	Coral reefs and rocky bottoms (20-200 m; 65-656 ft), and spawn offshore in spring-summer
Wenchman	Continental shelf waters, warmer months	Continental shelf waters, warmer months			Hard bottoms of the mid- to outer shelf (80-200 m; 262-656 ft), feed on small fish, and spawn in burrows and cervices in summer and fall

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Blueline and goldface, tilefishes	Pelagic and occur offshore	Pelagic and occur offshore		Pelagic and occur offshore	Continental shelf edge and upper slope (91-150 m; 298-492 ft) associated with irregular bottoms, feed on benthic invertebrates and some fish, and spawn in burrows and crevices in summer and fall
Tilefish	Pelagic and occur on the near shelf edge in the spring and summer	Pelagic and occur on the near shelf edge in the spring and summer			Outer continental shelf (>250 m; 820 ft), feed on crustaceans, burrow in clay, and spawn spring to fall
Speckled hind	Pelagic and occur offshore	Pelagic and occur offshore		Shallow waters	Hard bottoms/ rocky reefs commonly at 60-120 m (196-393 ft); they are the apex predator of the mid-shelf coral reef and spawn at continental shelf edge in spring and late summer
Yellowedge grouper	Pelagic and occur offshore	Pelagic and occur offshore		Shallow waters with rocky bottom habitats	Outer continental shelf (>180 m; 590 ft) with high relief, hard-bottom habitats; feed on nekton; and spawn in the spring and summer

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Goliath grouper (protected)	Pelagic and occur offshore in the late summer and early fall	Pelagic and occur offshore in the late summer and early fall		High salinity (>25 psu) estuaries and bays, and feed on crustaceans and vegetation	Near jetties, coral reefs, and crevices at 2-55 m (6-180 ft); feed on crustaceans; and spawn from summer to winter with peaks in the late summer offshore in structures or patchy reefs
Red grouper	Pelagic and occur offshore over the continental shelf, and feed on zooplankton	Pelagic and occur offshore over the continental shelf, and feed on zooplankton		Inshore by seagrass and rock formation, have wide salinity range, feed on crustaceans, and move into deeper waters with size	Continental shelf near live bottoms and crevices (3-190 m; 9-623 ft), feed on nekton, and spawn offshore as protogynous hermaphrodites in late the winter and spring
Marbled grouper (insufficient information to identify EFH)					
Snowy grouper	Pelagic and occur offshore	Pelagic and occur offshore		Benthic and found inshore associated with shallow reefs, feed on nekton, and move offshore with size	Deepwater (100-200 m; 328-656 ft) with high-relief rocky bottoms, feed on nekton, and spawn in spring and summer
Nassau grouper (protected)	Not offshore but are in highly saline waters in the winter	Not offshore but are in highly saline waters in the winter, and start feeding on other larvae		Saline, shallow, vegetated waters or associated with reefs in similar waters, move offshore with size, and start feeding on fishes	Associated with reeds and crevices, feed on nekton, and spawn in the winter at full moon over soft corals, sponges, and sand

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Black grouper	Pelagic and occur offshore	Pelagic and occur offshore		Inshore to estuaries with seagrass, rocky bottoms, or coral reefs, eat crustaceans, and move to deeper water with size	Deeper (>20 m; 65 ft) waters than the other life history stages over rocky bottoms and coral reefs (mid to high relief), feed on fish, and spawn in May near the Florida Keys
Yellowmouth grouper	Pelagic and occur offshore	Pelagic and occur offshore		Shallow waters with mangroves (e.g., lagoons) and feed on fishes	Inshore in water depths <100 m (328 ft) over rocky bottom and corals, feed on nekton, and spawn in spring and summer
Gag	Pelagic and occur in the winter to spring	Pelagic and occur in the winter to spring, shallow (<5 m; 16 ft) estuaries associated with grass beds or oysters, eat crustaceans then nekton, and then recruit to offshore hard bottoms in the fall			In water depths of 20-100 m (65-326 ft) associated with hard bottoms that have some relief, feed on nekton, and spawn offshore shelf edge break in the winter but peaking in the spring
Scamp	Pelagic and occur offshore in the spring	Pelagic and occur offshore in the spring		Inshore associated with hard bottoms	Continental shelf associated with high-relief hard bottoms that have complex structure, feed on nekton, and spawn at the continental shelf edge (60-100 m; 196-328 ft) in complex habitat from early spring to summer

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Yellowfin grouper				Seagrass beds then move to rocky bottoms	Adults are not common but can be found near the shoreline to mid-shelf with rocky bottoms and coral reefs, feed on nekton, and spawn in spring and summer

Table D-3

Described Essential Fish Habitat Locations for Coastal Migratory Species

Species	Eggs	Larvae	Juveniles	Adults
King mackerel	Pelagic and occur offshore in spring and summer	Mid to outer continental shelf (25-180 m; 82-590 ft) in October and feed on other larval fishes	Inshore waters on the inner shelf and feed on estuarine dependent fish	Pelagic and occur in coastal to offshore waters, feed on nekton, and spawn from May to October on the outer continental shelf
Spanish mackerel	Pelagic and found on the continental inner shelf (<50 m; 164 ft) in spring and summer	Continental inner shelf from spring to fall and feed on larval fishes	Estuarine and coastal waters with a wide salinity range and feed on fishes	Inshore and coastal waters, feed on estuarine dependent fishes, and spawn on the inner shelf from May to September
Cobia	Top meter of the water column	Offshore waters	Coastal waters and offshore on the shelf in the upper water column, found in the summer, and feed on nekton	Shallow coastal waters and offshore shelf waters (1-70 m; 3-229 ft) from March to October and spawn in the shelf waters in the spring and summer

Table D-4

Described Essential Fish Habitat and Spawning Locations for Shrimp in the Gulf of Mexico

Species	Eggs	Larvae	Post larvae	Juveniles	Adult
Brown shrimp			Migrate to estuaries in early spring	Associated with vegetation and mud bottoms, and sub-adults utilize bays and shelf as they move from estuaries to offshore waters	Spawn in deep waters (>18 m; 59 ft) over the continental shelf generally in the spring
White shrimp	Spring and fall			Associated with soft bottoms with detritus and vegetation	Nearshore soft bottoms and spawn at <27 m (88 ft) from spring to fall, and migrate through the water column between night and day
Pink shrimp	Spring and summer			Utilize the seagrass beds (*Halodule* and *Thalassia*, depending on size)	Offshore over the continental shelf on sand/shell bottoms
Royal red shrimp	Winter and spring on the upper slope (250-550 m; 820-1,804 ft)				Upper slope associated with muddy bottoms and spawn there from winter to spring, feed on benthic organisms, and are not estuarine dependent

Table D-5

Described Essential Fish Habitat Locations for Highly Migratory Species in the Gulf of Mexico

Species	Eggs	Larvae	Juvenile	Adult
Atlantic bluefin tuna	100 m (328 ft) to the EEZ	100 m (328 ft) to the EEZ		Spawn in the spring over the continental shelf in the Gulf
Atlantic bigeye tuna			Found in waters adjacent to Louisiana/Mississippi and Florida*	Central Gulf**
Atlantic yellowfin tuna	Offshore	Offshore	Central Gulf from Texas to the Florida panhandle	Offshore
Albacore tuna				Central Gulf
Skipjack tuna	Offshore out to the EEZ	Offshore out to the EEZ	Central Gulf waters from Louisiana to Florida	Central Gulf waters from Texas to Florida and spawn offshore
Swordfish	100 fathoms (200 m; 656 ft) to the EEZ	100 fathoms (200 m; 656 ft) to the EEZ	Gulf waters from Texas to Florida	Spawn offshore associated with the Loop Current
Blue marlin	Mid-Florida Keys	Mid-Florida Keys	Central Gulf waters from Texas to Florida	Central Gulf waters from Texas to Florida
White marlin			Central Gulf from Texas to the Florida panhandle and Keys	Central Gulf from Texas to the Florida panhandle and Keys
Sailfish			Central Gulf waters from Texas, Louisiana, and the Florida panhandle	Central Gulf waters from Texas, Louisiana, and the Florida panhandle
Longbill spearfish			Central Gulf from Louisiana to the Florida panhandle and the Keys	Central Gulf from Louisiana to the Florida panhandle and the Keys

EEZ = Economic Exclusion Zone.
*The states are used to help visualize approximately where in the Gulf the species could occur.
**Central Gulf—This is the central portion of the entire Gulf of Mexico, not the Gulf of Mexico's Central Planning Area (CPA).

Table D-6

Described Essential Fish Habitat Locations for Shark Species

Shark Species	Neonates	Young of Year (YOY)	Juveniles	Adult
Basking shark (no EFH described for the Gulf)				
Great hammerheads				Coastal areas from Texas to Florida*
Scalloped hammerhead	Coastal waters from Texas to Florida	Coastal waters from Texas to Florida	Coastal and offshore waters from mid-Texas to Louisiana	Coastal Gulf waters from Texas to Florida and offshore waters from Texas to eastern Louisiana
Smooth hammerhead (no EFH identified due to insufficient data)				
White sharks				Southwest coastal waters of Florida and Florida Keys
Nurse sharks				Coastal waters of Florida
Bignose shark			Localized areas from Louisiana to the Florida Keys	Localized areas from Louisiana to the Florida Keys
Blacktip sharks				Coastal waters from Texas to the Florida Keys
Bull shark	Coastal waters of Texas but are also found in localized areas in Florida	Coastal waters of Texas, but are also found in localized areas in Florida	Coastal waters from Texas through eastern Louisiana to the panhandle and western Florida	Southern and mid-coast of Texas to Louisiana and the Florida Keys
Caribbean reef sharks				Coastal waters of the Florida Keys
Dusky shark			Central Gulf** adjacent to south Texas and Florida	Central Gulf adjacent to south Texas and Florida
Galapagos shark (no EFH identified due to insufficient data)				

Table D-6. Described Essential Fish Habitat Locations for Shark Species (continued).

Shark Species	Neonates	Young of Year (YOY)	Juveniles	Adult
Lemon shark	Found in waters adjacent to mid-Texas and the Florida Keys with a localized area adjacent to the middle of Florida	Found in waters adjacent to mid-Texas and the Florida Keys with a localized area adjacent to the middle of Florida	Found in coastal waters of Texas, eastern Louisiana, and Florida	Coastal waters adjacent to Florida
Narrowtooth shark (no EFH identified due to insufficient data)				
Night sharks				Found in localized areas of offshore waters adjacent to Texas, Louisiana, and Florida
Sandbar shark				Coastal waters near Florida and some localized areas near Alabama
Silky sharks				Offshore waters in the Central Gulf adjacent to Texas, Louisiana, and the Florida Keys
Spinner shark	Coastal waters near Texas, Louisiana, and Florida	Coastal waters near Texas, Louisiana, and Florida	Localized in waters reaching from south Texas to Florida	Localized in waters reaching from south Texas to Florida
Tiger sharks	Localized areas near the Texas/Louisiana border and Florida panhandle	Localized areas near the Texas/Louisiana border and Florida panhandle	Found in Florida waters	Found in both shallow and deep waters
Bigeye sand shark (no EFH identified due to insufficient data)				
Sand shark (no EFH described in the Gulf)				
Whale sharks				Found in the waters of the central Gulf ranging from Texas to the Florida panhandle
Atlantic angel shark			Localized in coastal waters from eastern Louisiana to the Florida panhandle	Localized in coastal waters from eastern Louisiana to the Florida panhandle

Table D-6. Described Essential Fish Habitat Locations for Shark Species (continued).

Shark Species	Neonates	Young of Year (YOY)	Juveniles	Adult
Caribbean sharpnose shark (no EFH identified due to insufficient data)				
Bonnethead shark				Found in coastal shallow waters with sandy and muddy bottoms around Texas, eastern Mississippi, and to the Florida Keys
Atlantic sharpnose shark				Found in coastal waters from Texas to the Florida Keys
Blacknose shark	Found in the coastal waters of Florida	Found in the coastal waters of Florida	Localized in the coastal waters of Texas, western Louisiana, and Mississippi to Florida	Localized areas in waters from Texas to the Florida Keys
Finetooth shark	Inshore waters from Texas, eastern Louisiana, Mississippi, Alabama, and the Florida panhandle	Inshore waters from Texas, eastern Louisiana, Mississippi, Alabama, and the Florida panhandle	Found in inshore waters from south Texas and the Florida Keys, and from eastern Louisiana to the Florida panhandle	Found in inshore waters from south Texas and the Florida Keys, and from eastern Louisiana to the Florida panhandle
Oceanic whitetip shark				Found in the central Gulf and the Florida Keys
Common thresher shark				Found in the central Gulf and the Florida Keys
Bigeye thresher shark				Found in the central Gulf and Key West, Florida
Longfin makos and shortfin makos				Deepwater offshore in the central Gulf and the Florida Keys
Porbeagle shark (no EFH described for the Gulf)				
Blue shark (no EFH described for the Gulf)				

*The states are used to help visualize approximately where in the Gulf the species could occur.
**Central Gulf—This is the central portion of the entire Gulf of Mexico, not the Gulf of Mexico's Central Planning Area (CPA).

APPENDIX E

COOPERATING AGENCY

Memorandum of Agreement between
The Bureau of Ocean Energy Management, Regulation and Enforcement, Gulf of Mexico Outer Continental Shelf (OCS) Region and the U. S. Environmental Protection Agency, Region 6, for Preparation of the Multisale Environmental Impact Statement, Gulf of Mexico, Central and Western Planning Areas, 2012-2017

INTRODUCTION

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) prepares Environmental Impact Statements (EIS) to assess the consequences of the proposed oil and gas lease sales on the Outer Continental Shelf (OCS). The BOEMRE's EIS preparation process complies with the provisions of the National Environmental Policy Act (NEPA) as detailed in the Council for Environmental Quality's (CEQ) regulations 40 CFR 1500.

The U.S. Environmental Protection Agency (EPA) has authority under the Clean Water Act (CWA) Section 402 to issue National Pollutant Discharge Elimination System (NPDES) permits to regulate discharges to waters of the United States. Section 306 and 40 CFR 122.29 of the CWA requires that a NEPA document be prepared when EPA issues an NPDES permit to a new source.

Section 1501.6 of the CEQ's regulations emphasizes agency cooperation in the NEPA process between federal agencies either having overlapping jurisdiction or special expertise related to a proposed action. The March 31, 1984, Memorandum of Understanding (MOU) between EPA and the Department of the Interior outlines provisions for the coordination of NPDES permits issuance with lease offerings and NEPA responsibilities.

The BOEMRE is preparing an EIS for oil and gas lease sales in the 5-Year Program for 2012-2017. This Memorandum of Agreement (MOA) outlines the responsibilities agreed to by BOEMRE and EPA with respect to preparation of this EIS. This MOA does not affect EPA's independent review responsibilities under Section 309 of the Clean Air Act. The EPA will conduct an official Section 309 review on all appropriate sections of the EIS. This MOA does not affect BOEMRE's responsibilities under the OCS Lands Act and regulations under 30 CFR 250.

BOEMRE RESPONSIBILITIES

BOEMRE is the lead agency for preparation of the EIS.

BOEMRE will designate a primary point of contact for matters related to the MOA.

BOEMRE will have the lead in setting up and holding public hearings for the draft EIS.

BOEMRE will provide EPA copies or a summary of all comments received during preparation of the EIS, including comments received during the scoping process, public meetings/hearings, and circulation of the EIS.

BOEMRE will provide EPA with early versions of the EIS sections dealing with water quality and air quality.

BOEMRE will place a copy of the MOA in an appendix to the EIS.

EPA RESPONSIBILITIES

EPA is a cooperating agency for preparation of the EIS.

EPA will designate a primary point of contact to represent EPA in matters related to this MOA.

EPA will provide available water quality and air quality information that they may have collected or obtained including any summary reports.

Comments on the draft EIS are official agency comments only if signed by the Regional Administrator, or authorized designee.

The comments provided by EPA to BOEMRE are advisory.

During EPA's participation in the review and comment process, EPA will comply with the EIS preparation schedule for the BOEMRE.

EPA will be responsible for any expenses incurred by EPA related to this MOA.

TERMINATION

The MOA may be terminated by written notice by either of the below signatories at any time.

LIMITATIONS

All commitments made in the MOA are subject to the availability of appropriated funds and each agency's budget priorities. Nothing in the MOA obligates BOEMRE or EPA to expend appropriations or to enter into any contract, assistance agreement, interagency agreement, or incur other financial obligations.

This MOA is neither a fiscal nor a funds obligation document. Any endeavor involving reimbursement or contribution of funds between the parties to this MOA will be handled in accordance with applicable laws, regulations, and procedures, and will be subject to separate subsidiary agreements that will be effected in writing by representatives of both parties.

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This MOA does not create any right or benefit enforceable against the BOEMRE or EPA, their officers or employees, or any other person. This MOA does not apply to any person outside BOEMRE and EPA.

PREDECISIONAL MATERIALS

The undersigned hereby agrees to maintain confidentiality of information and documents shared between EPA and the BOEMRE completion of this EIS, to the extent authorized under the Freedom of Information Act (FOIA). These confidentiality provisions apply to all communications, including: e-mail messages; notes to the file; agendas, pre-meeting materials, presentations, and meeting notes or summaries; letters, reviews evaluations, and all documents created and shared as part of the collaboration established in this MOA.

Date: 5-27-11

Joseph A. Christopher
Regional Supervisor, Leasing and Environment Section
Bureau of Ocean, Energy, Management, Regulation, and Enforcement
Gulf of Mexico OCS Region

Date: 5-17-11

John Blevins
Director, Compliance Assurance and Enforcement Division
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Region 6

APPENDIX F

STATE COASTAL MANAGEMENT PROGRAMS

F. STATE COASTAL MANAGEMENT PROGRAMS

Each State's Coastal Management Program (CMP), federally approved by the National Oceanic and Atmospheric Administration (NOAA), is a comprehensive statement setting forth objectives, enforceable policies, and standards for public and private use of land and water resources and uses in that State's coastal zone. The program provides for direct State land and water use planning and regulations. The plan also includes a definition of what constitutes permissible land uses and water uses. Federal consistency is the Coastal Zone Management Act (CZMA) requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. The latest Federal consistency regulations concerning State coastal zone management programs are found in the *Federal Register* at 65 FR 77123-77154 (December 8, 2000) and 71 FR 788-831 (January 5, 2006).

Each Gulf State's official coastal boundary can be identified from NOAA's website at http://coastalmanagement.noaa.gov/mystate/docs/StateCZBoundaries.pdf. Once a State's CMP is federally approved, Federal agencies must ensure that their actions are consistent to the maximum extent practicable with the enforceable polices of the approved program. Federal agencies provide feedback to the States through each Section 312 evaluation conducted by NOAA.

To ensure conformance with State CMP policies and local land use plans, the Bureau of Ocean Management (BOEM) prepares a Federal consistency determination for each proposed Outer Continental Shelf (OCS) lease sale. Through the designated State CZM agency, local land use entities are provided numerous opportunities to comment on the OCS Program. Local land-use agencies also have the opportunity to comment directly to BOEM at any time, as well as during formal public comment periods related to the announcement of the Five-Year Program, Call for Information/Notice of Intent, environmental impact statement (EIS) scoping, public hearings on the Draft EIS, and the Proposed Notice of Sale.

A State's approved CMP may also provide for the State's review of OCS plans, permits, and license activities to determine whether they will be conducted in a manner consistent with the State's CMP. This review authority is applicable to activities conducted in any area that has been leased under the OCS Lands Act (OCSLA) and that affect any land or water use or natural resource within the State's coastal zone (16 U.S.C. 1456(c)(3)(B)).

State of Texas Coastal Management Program

The Texas Coastal Management Program (TCMP)/Final EIS was published in August 1996. On December 23, 1996, NOAA approved the TCMP, and the requirements therein were made operational as of January 10, 1997. The TCMP is based primarily on the Coastal Coordination Act (CCA) of 1991 (33 Tex. Nat. Res. Code Ann. Ch. 201, et seq.), as amended by HB 3226 (1995), which calls for the development of a comprehensive coastal program based on existing statutes and regulations. The CCA established the geographic scope of the program by identifying the program's inland, interstate, and seaward boundaries. The program's seaward boundary is the State's territorial seaward limit (3 leagues or 10.36 miles [mi]). The State's inland boundary is based on the State's Coastal Facilities Designation Line (CFDL). The CFDL was developed in response to the Oil Spill Act of 1990 and basically delineates those areas within which oil spills could affect coastal waters or resources. For the purposes of the TCMP, the CFDL has been modified to capture wetlands in upper reaches of tidal waters. The geographic scope also extends upstream 200 miles (322 kilometers) from the mouths of rivers draining into coastal bays and estuaries in order to manage water appropriations on those rivers. The program's boundaries encompass all or portions of 18 coastal counties (including Cameron, Willacy, Kenedy, Kleberg, Nueces, San Patricio, Aransas, Refugio, Calhoun, Victoria, Jackson, Matagorda, Brazoria, Galveston, Harris, Chambers, Jefferson, and Orange Counties), roughly 8.9 million acres (3.6 million hectares) of land and water.

Within this coastal zone boundary, the scope of the TCMP's regulatory program is focused on the direct management of 16 generic "Areas of Particular Concern," called coastal natural resource areas (CNRA's). These CNRA's are associated with valuable coastal resources or vulnerable or unique coastal areas and include the following: waters of the open Gulf of Mexico (GOM); waters under tidal influence;

submerged lands; coastal wetlands; seagrasses; tidal sand and mud flats; oyster reefs; hard substrate reefs; coastal barriers; coastal shore areas; GOM beaches; critical dune areas; special hazard areas; critical erosion areas; coastal historic areas; and coastal preserves.

The State has designated the Western Planning Area (WPA) as the geographical area in which Federal consistency shall apply outside of the coastal boundary. The TCMP also identifies Federal lands excluded from the State's coastal zone, such as U.S. Department of Defense facilities and wildlife refuges.

Land and water uses subject to the program generally include the siting, construction, and maintenance of electric generating and transmission facilities; oil and gas exploration and production; and the siting, construction, and maintenance of residential, commercial, and industrial development on beaches, critical dune areas, shorelines, and within or adjacent to critical areas and other CNRA's. Associated activities also subject to the program include canal dredging; filling; placement of structures for shoreline access and shoreline protection; on-site sewage disposal, storm-water control, and waste management for local governments and municipalities; the siting, construction, and maintenance of public buildings and public works such as dams, reservoirs, flood control projects and associated activities; the siting, construction, and maintenance of roads, highways, bridges, causeways, airports, railroads, and nonenergy transmission lines and associated activities; certain agricultural and silvicultural activities; water impoundments and diversions; and the siting, construction, and maintenance of marinas, State-owned fishing cabins, artificial reefs, public recreational facilities, structures for shoreline access and shoreline protection, boat ramps, and fishery management measures in the GOM.

The TCMP is a networked program that is implemented primarily through 8 State agencies, 18 local governments, and the Coastal Coordination Council (Council). The program relies primarily on direct State control of land and water uses, although local governments will implement State guidelines related to beach and dune management. Implementation and enforcement of the coastal policies is primarily the responsibility of the networked agencies and local governments through their existing statutes, regulatory programs, or other authorizations. Networked agencies include the General Land Office/School Land Board, Texas Commission on Environmental Quality, Railroad Commission of Texas, Parks and Wildlife Commission, Texas Transportation Commission, Texas Historical Commission, the Public Utility Commission, the Texas State Soil and Water Conservation Board, and the Texas Water Development Board. In addition, the Texas Sea Grant College Program is a nonvoting member of the Council. Other members on the Council include four gubernatorial appointees: a coastal business representative, an agriculture representative, a local elected official, and a coastal citizen. Similarly, 18 county and municipal governments, in those counties with barrier islands, are also networked entities with responsibilities for program implementation vis-a-vis beaches and dunes.

Local land uses and government entities are linked to the management of Texas CNRA's in the TCMP. Local governments are notified of relevant TCMP decisions, including those that may conflict with local land-use plans or zoning ordinances. The Coastal Coordination Council includes a local government representative as a full-voting member. An additional local government representative can be added to the Council as a nonvoting member for special local matters under review. The Council will establish a permanent advisory committee to ensure effective communication for local governments with land-use authority.

In 1994, this Agency entered into a Memorandum of Understanding (MOU) with the Texas General Land Office to address similar mineral resource management responsibilities between the two entities and to encourage cooperative efforts and promote consistent regulatory practices. This MOU, which encompasses a broad range of issues and processes, outlines the responsibilities and cooperative efforts, including leasing and CZMA review processes, agreed to by the respective agencies. Effective January 10, 1997, all operators were required to submit to BOEM certificates of consistency with the TCMP for proposed operations in the WPA.

This Agency developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. The WPA Lease Sale 168 was this Agency's first Federal action subject to State consistency review. This Agency and the State of Texas revised CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest Notices to Lessees and Operators (NTL's) (NTL's 2010-N06 and 2009-G27). The State of Texas requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a federal consistency certification, assessment, and findings. The State's requirements for Federal consistency review are based specifically on U.S. Department of the Interior's (DOI's) regulations at 30 CFR 550, 30 CFR 254, 30 CFR 250, 30 CFR 256, and NOAA's Federal consistency regulations at 15 CFR 930. This Agency will be continuing a dialogue with the State of Texas on reasonably foreseeable coastal effects for pipelines and other permits, and the result of these discussions will be incorporated into future updates of this Agency's NTL's and/permitting procedures.

State of Louisiana Coastal Resources Program

The statutory authority for Louisiana's coastal zone management program, the Louisiana Coastal Resources Program (LCRP), is the State and Local Coastal Resources Management Act of 1978, *et seq*. (Louisiana Administrative Code, Vol. 17, Title 43, Chapter 7, Coastal Management, June 1990 revised). The State statute puts into effect a set of State coastal policies and coastal use guidelines that apply to coastal land and water use decisionmaking. A number of existing State regulations are also incorporated into the program including those concerning oil and gas and other mineral operations; leasing of State lands for mineral operations and other purposes; hazardous waste and radioactive materials; management of wildlife, fish, other aquatic life, and oyster beds; endangered species; air and water quality; and the Louisiana Superport.

The State statute also authorized establishment of Special Management Areas. Included or planned to be included as Special Management Areas are LOOP and Marsh Island. For purposes of the CZMA, only that portion of LOOP within Louisiana's coastal zone is part of the Special Management Area. In April 1989, the Louisiana Legislature created the Wetlands Conservation and Restoration Authority and established a Wetlands Conservation and Restoration Trust Fund to underwrite restoration projects. The Legislature also reorganized part of the Louisiana Department of Natural Resources (LDNR, LADNR) by creating the Office of Coastal Restoration and Management.

Local governments (parishes) may assume management of uses of local concern by developing a local coastal program consistent with the State CMP. The State of Louisiana has 11 approved local coastal management programs (Calcasieu, Cameron, Jefferson, Lafourche, Orleans, St. Bernard, St. James, St. John the Baptist, Plaquemines, Terrebonne, and St. Tammany Parishes). Eight other programs (Assumption, Iberia, Livingston, St. Charles, St. Martin, St. Mary, Tangipahoa, and Vermilion Parishes) have not been formally approved by NOAA. The parish planning and/or permits offices often serve as the permitting agency for projects limited to local concern. Parish-level programs, in addition to issuing permits for uses of local concern, also function as a commenting agency to Louisiana's CZM agency, the Coastal Management Division, regarding permitting of uses of State concern.

Appendix C2 of the LCRP outlines the rules and procedures for the State's local CMP. Under the LCRP, parishes are authorized, though not required, to develop local CMP. Approval of these programs gives parishes greater authority in regulating coastal development projects that entail uses of local concern. Priorities, objectives, and policies of local land use plans must be consistent with the policies and objectives of Act 361, the LCRP, and the State guidelines, except for a variance adopted in Section IV.D. of Appendix C2 of the LCRP. The Secretaries of DNR and Wildlife and Fisheries may jointly rule on an inconsistent local program based on local environmental conditions or user practices. State and Federal agencies review parish programs before they are adopted.

The coastal use guidelines are based on seven general policies. State concerns that could be relevant to an OCS lease sale and its possible direct effects or associated facilities and nonassociated facilities are (a) any dredge and fill activity that intersects more than one water body, (b) projects involving the use of State-owned lands or water bottoms, (c) national interest projects, (d) pipelines, and (e) energy facility siting and development. Some coastal activities of concern that could be relevant to a lease sale include wetland loss due to channel erosion from OCS traffic; activities near reefs and topographic highs; activities that might affect endangered, threatened, or commercially valuable wildlife; and potential socioeconomic impacts due to offshore development. Secondary and cumulative impacts to coastal resources such as onshore facility development, cumulative impacts from infrastructure development, salt intrusion along navigation channels, etc. are also of particular concern.

Effective August 1993, the DNR Coastal Management Division required that any entity applying for permits to conduct activities along the coast must notify the landowner of the proposed activity. An affidavit must also accompany any permit application. Through this regulation, the State strives to minimize coastal zone conflicts.

This Agency and the State of Louisiana revised CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2010-N06 and 2009-G27). Federal consistency for right-of-way (ROW) pipelines is addressed in NTL 2007-G20. The State of Louisiana requires an adequate description, objective, and schedule for the project. Also, the State requires site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges (including any disposal of wastes within the State coastal zone and waters and municipal, parish, or State facilities to be used), transportation activities, air emissions, and secondary and cumulative impacts; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/enforpols.pdf. The State requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR 550, 30 CFR 254, 30 CFR 256, and NOAA's Federal consistency regulations at 15 CFR 930. The BOEM is continuing a dialogue with the State of Louisiana on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of BOEM's NTL's and/or permitting procedures.

State of Mississippi Coastal Program

The Mississippi Coastal Program (MCP) is administered by the Mississippi Department of Marine Resources. The MCP is built around several enforceable goals that promote comprehensive management of coastal resources and encourage a balance between environmental protection/preservation and development in the coastal zone. The primary coastal management statute is the Coastal Wetlands Protection Law. Other major features of the MCP include statutes related to fisheries, air and water pollution control, surface and groundwater, cultural resources, and the disposal of solid waste in marine waters. The Department of Marine Resources, the Department of Environmental Quality, and the Department of Archives and History are identified collectively as the "coastal program agencies." Mississippi manages coastal resources by regulation and by promoting activities that use resources in compliance with the MCP. The State developed a coastal wetlands use plan, which includes designated use districts in coastal wetlands and Special Management Area Plans that steer development away from fragile coastal resources and help to resolve user conflicts.

For the purposes of the coastal program, the coastal zone encompasses the three coastal counties of Hancock, Harrison, and Jackson and all coastal waters. The Mississippi coast has 369 miles (594 kilometers) of shoreline, including the coastlines of offshore barrier islands (Cat, Ship, Horn, and Petit Bois Islands). According to NOAA, there are no approved local (CMP's) for the State of Mississippi. The Southern Mississippi Planning and Development District serves in an advisory capacity to the State coastal agencies.

This Agency developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. This Agency and the State of Mississippi revised CZM consistency information for OCS plans, permits and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL (NTL's 2010-N06 and 2009-G27). Federal consistency for ROW pipelines is addressed in NTL 2007-G20. The State of Mississippi requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/enforpols.pdf. The State requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR 550, 30 CFR 254, 30 CFR 256, and NOAA's Federal consistency requirements at 15 CFR 930. The BOEM is continuing a dialogue with the State of Mississippi on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of BOEM's NTL's and/or permitting procedures.

State of Alabama Coastal Area Management Program

The Alabama Coastal Area Act (ACAA) provides statutory authority to review all coastal resource uses and activities that have a direct and significant effect on the coastal area. The Alabama Department of Conservation and Natural Resources (ADCNR) Lands Division, Coastal Section Office, the lead coastal management agency, is responsible for the management of the State's coastal resources through the Alabama Coastal Area Management Program (ACAMP). The ADCNR is responsible for the overall management of the program including fiscal and grants management and public education and information. The department also provides planning and technical assistance to local governments and financial assistance to research facilities and units of local government when appropriate. The State Lands Division, Coastal Section, also has authority over submerged lands in regard to piers, marinas, bulkheads, and submerged land leases.

The Alabama Department of Environmental Management (ADEM) is responsible for coastal area permitting, regulatory and enforcement functions. Most programs of ADCNR Coastal Section that require environmental permits or enforcement functions are carried out by the ADEM with the exception of submerged land issues. The ADEM has the responsibility of all permit, enforcement, regulatory, and monitoring activities, and the adoption of rules and regulations to carry out the ACAMP. The ADEM must identify specific uses or activities that require a State permit to be consistent with the coastal policies noted above and the more detailed rules and regulations promulgated as part of the ACAMP. Under the ACAA, State agency activities must be consistent with ACAMP policies and ADEM findings. Further, ADEM must make a direct permit-type review for uses that are not otherwise regulated at the State level. The ADEM also has authority to review local government actions and to assure that local governments do not unreasonably restrict or exclude uses of regional benefit. Ports and major energy facilities are designated as uses of regional benefit. The ADCNR Lands Division manages all lease sales of State, submerged bottomlands and regulates structures placed on State, submerged bottomlands.

Local governments have the option to participate in the ACAMP by developing local codes, regulations, rules, ordinances, plans, maps, or any other device used to issue permits or licenses. If these instruments are certified to be consistent with ACAMP, ADEM may allow the local government to administer them by delegating its permit authority, thereby eliminating the need for ADEM's case-by-case review.

The South Alabama Regional Planning Commission provides ongoing technical assistance to ADCNR for Federal consistency, clearinghouse review, and public participation procedures. Uses subject to the Alabama's CZMP are divided into regulated and nonregulated categories. Regulated uses are those that have a direct and significant impact on the coastal areas. These uses either require a State permit or are required by Federal law to be consistent with the management program. Uses that require a State permit must receive a certificate of compliance. Nonregulated uses are those activities that have a direct and significant impact on the coastal areas that do not require a State permit or Federal consistency certification. Nonregulated uses must be consistent with ACAMP and require local permits to be administered by ADEM.

This Agency developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. This Agency and the State of Alabama have revised CZM consistency information for OCS plans, permits and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2010-N06 and 2009-G27). Federal consistency for ROW pipelines is addressed in NTL 2007-G20. The State of Alabama requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/enforpols.pdf. The State's requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR 550, 30 CFR 254, 30 CFR 256, and NOAA's Federal consistency requirements at 15 CFR 930. The BOEM is continuing a dialogue with the State of Alabama on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of BOEM's NTL's and/or permitting procedures.

State of Florida Coastal Management Program

For purposes of the CZMA, the State of Florida's coastal zone includes the area encompassed by the State's 67 counties and its territorial seas. Lands owned by the Federal Government and the Seminole and Miccosukee Indian tribes are not included in the State's coastal zone; however, Federal activities in or outside the coastal zone, including those on Federal or tribal lands, that affect any land or water or natural resource of the State's coastal zone are subject to review by Florida under the CZMA. The Florida Coastal Management Act, codified as Chapter 380, Part II, Florida Statutes, authorized the development of a coastal management program. In 1981 the Florida Coastal Management Program (FCMP) was approved by NOAA.

The policies identified by the State of Florida as being enforceable in the FCMP are the 24 chapters that NOAA approved for incorporation in the State's program. The 2011 Florida Statutes are the most recent version approved by NOAA and include the listing of OCSLA permits under Subpart E; and the addition of draft EA's and EIS's as necessary data and information for Federal consistency review

A network of eight State agencies and five regional water management districts implement the FCMP's 24 statutes. The water management districts are responsible for water quantity and quality throughout the State's watersheds. The State agencies include the following: the Department of Environmental Protection (DEP), the lead agency for the FCMP and the State's chief environmental regulatory agency and steward of its natural resources; the Department of Community Affairs, which serves as the State's land planning and emergency management agency; the Department of Health, which, among other responsibilities, regulates on-site sewage disposal; the Department of State, Division of Historical Resources, which protects historic and archaeological resources; the Fish and Wildlife Conservation Commission, which protects and regulates fresh and saltwater fisheries, marine mammals, and birds and upland species, including protected species and the habitat used by these species; the Department of Transportation, which is charged with the development, maintenance, and protection of the transportation system; the Department of Agriculture and Consumer Services, which manages State forests and administers aquaculture and mosquito control programs; and the Governor's Office of Planning and Budget, which plays a role in the comprehensive planning process.

Effective July 1, 2000, the Governor of Florida assigned the State's responsibilities under the OCSLA to the Secretary of the Florida DEP. The DEP's Office of Intergovernmental Programs coordinates the review of OCS plans with FCMP member agencies to ensure that the plan is consistent with applicable State enforceable policies and the Governor's responsibilities under the Act.

This Agency developed coordination procedures with the State for the submittal of offshore lease sale consistency determinations and plans of operation. In 2003, this Agency and the State revised CZM consistency information for OCS plans, permits, and licenses to conform with the revised CZM regulations that were effective on January 8, 2001, and updated on January 5, 2006, and they have also incorporated streamlining improvements into the latest NTL's (NTL's 2010-N06 and 2009-G27). Federal consistency for ROW pipelines is addressed in NTL 2007-G20.

The State of Florida requires an adequate description, objective, and schedule for all activities associated with a project; specific information on the natural resources potentially affected by the proposed activities; and specific information on onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. As identified by the State of Florida, the State enforceable policies that must be addressed for OCS activities are found at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/enforpols.pdf. These requirements have been incorporated into the Plans and Regional Oil-Spill Response NTL's. The State requirements for Federal consistency review are based on the requirements of State statutes, CZMA regulations at 15 CFR 930, and DOI's regulations at 30 CFR 550, 30 CFR 254, and 30 CFR 256. The BOEM is continuing a dialog with the State of Florida on reasonably foreseeable coastal effects associated with OCS plans, pipelines, and other permits; the result of these discussions will be incorporated into future updates of the Bureau of Ocean Energy Management's NTL's and/or permitting procedures.

APPENDIX G

FIVE-YEAR PROGRAM EIS CONSIDERATIONS

G. FIVE-YEAR PROGRAM EIS CONSIDERATIONS

The U.S. Department of the Interior (DOI) proposes 15 lease sales in six of the Outer Continental Shelf (OCS) planning areas in the Gulf of Mexico (GOM) and offshore Alaska during the period 2012-2017. The *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017* (Five-Year Program) (USDOI, BOEM, 2012a) establishes a schedule that DOI will use as a basis for considering where and when leasing might be appropriate over a 5-year period. Five areawide lease sales each are scheduled in the Central Planning Area (CPA) and Western Planning Area (WPA), and 2 lease sales in the extreme western portion of the Eastern Planning Area (EPA). Scheduled in the Alaska Region would be one sale with two whaling deferrals in the Beaufort Sea Planning Area, one sale with a 40-kilometer (25-mile) coastal buffer in the Chukchi Sea Planning Area, and one special interest sale in the Cook Inlet Planning Area. No lease sales are proposed off the U.S. East and West Coasts. A decision to adopt the Five-Year Program proposal is not a decision to issue specific leases or to authorize any drilling or development.

The Five-Year Program is scheduled to begin in September 2012 and will be the eighth such program prepared since Congress amended the Outer Continental Shelf Lands Act (OCSLA) in 1988. The Five-Year Program establishes a framework for managing OCS oil and gas leasing in a manner that accounts for all of the factors required by the OCSLA. It also provides the public with a clear statement of the U.S. Department of the Interior's OCS leasing intentions during the period 2012-2017.

The *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017, Final Environmental Impact Statement* (Five-Year Program EIS) (USDOI, BOEM, 2012b) was prepared to evaluate the potential environmental impacts of alternatives for OCS oil and gas leasing under the Five-Year Program, and it presents those impacts in a comparative manner that provides a clear basis for making a reasoned choice among the alternatives by the decisionmaker. The analyses and evaluations in the Five-Year Program EIS are intended to inform decisionmakers on the size, timing, and location of leasing activity that will be made to create the schedule of lease sales for the Five-Year Program (43 U.S.C. 1344).

The Five-Year Program EIS informs decisionmakers by identifying the areas, environmental resources, and types of OCS activities that, acting together, suggest the potential for important interactions between environmental resources and OCS-related activities that could result in significant impacts. The Five-Year Program EIS identifies the broad issues that will likely require more focused and fine-scale evaluations in subsequent NEPA assessments, leading to the possible development and application of mitigations, should leasing and development occur.

For further information regarding the Five-Year Program and the Five-Year Program EIS, see BOEM's website at http://boem.gov/5-year/2012-2017. The Five-Year Program EIS is hereby incorporated by reference.

G.1. PROGRAMMATIC NO ACTION ALTERNATIVE—CANCELLATION OF A FIVE-YEAR PROGRAM OF PROPOSED LEASE SALES IN THE GULF OF MEXICO

This EIS examines the impacts of proposed lease sales in the Western Planning Area (WPA) and the Central Planning Area (CPA) that are part of a Five-Year Program of proposed OCS lease sales. **Chapters 4.1.3 and 4.2.3** describe the No Action alternative as the cancellation of a proposed lease sale in the WPA or CPA. This Appendix discusses the impacts of the cancellation of a Five-Year Program of proposed lease sales in the Gulf of Mexico (GOM).

The NEPA requires consideration of a No Action alternative for every major Federal action that could result in significant impacts on the environment. In the context of the Five-Year Program, the No Action alternative is defined as the scenario in which BOEM holds no OCS oil and gas lease sales during the Five-Year Program. Under this scenario, none of the potential environmental impacts associated with the oil- and gas-related activities under a proposed action, which have been evaluated in **Chapter 4**, would occur. These precluded or deferred impacts would include the anticipated effects of routine operations and accidental discharges on ecological conditions and the effects of leasing on regional employment, income, and regional prosperity and health under a proposed action. In addition, the oil and natural gas that would have been produced as a result of lease sales over the Five-Year Program would not be available to consumers.

The absence of these resources from the world market would precipitate a gradual reaction by nations, including the U.S. This reaction(s) would very likely be significant and also would be dependent on how complex and energy intense a country's economy has evolved to be. The No Action alternative depends on market-based or societal choices available to the U.S. to make up for, or switch from, oil and gas that would no longer be produced as a result of the cancellation of the Five-Year Program.

The typical duration of activity that results from a lease sale extends over a long period, sometimes in excess of 40 years. The OCS land, once leased, has a lag time of several years between acquisition of the leases and the first production for a successful hydrocarbon development project. This means that production that is lost or delayed by the selection of the No Action Alternative would begin to manifest itself between 2017 and 2027, and residual economic effects would last for additional decades.

Economic Impacts

A sudden change in policy that restricts access to oil and gas resources or that alters the timetables the offshore industry has come to rely on when making their investment decisions may lead to undesirable socioeconomic disruptions in local coastal economies (USDOI, MMS, 2007). Since 1983, this Agency has scheduled and held annual areawide lease sales in the Gulf of Mexico, canceling only two lease sales. In October 2006, this Agency and the State of Louisiana reached a settlement on the lawsuit filed by the State challenging WPA Lease Sale 200. As part of this settlement, this Agency canceled CPA Lease Sale 201, scheduled for March 2007. However, the acreage was offered 7 months later in CPA Lease Sale 205 (October 2007). This Agency cancelled WPA Lease Sale 215 in July 2010 after the *Deepwater Horizon* event. There are limitations to BOEM's awareness for what business decisions industry has made or intends to make that are the result of the cancellation of a single lease sale (e.g., WPA Lease Sale 215), let alone the consequences of the cancellation of all lease sales in the entire Gulf of Mexico under the Five-Year Program.

The cancellation of all lease sales of a Five-Year Program in the GOM (similar to "Alternative 8-No Action" in the Five-Year Program EIS, which covers the entire OCS) may have economic impacts on an industry that has planned their investments according to annual lease sales in the Gulf of Mexico. Smaller independent companies would have fewer alternative projects available in their investment portfolios and, thus, would be more affected by the cancellation of the lease sales. Therefore, smaller operators would have a more difficult time than major integrated companies or sovereign-nation companies replacing lost production capacity or deploying their assets in other geologic basins where they may not now be active or hold leases. The magnitude and length of economic impacts on industry would be dependent on individual operator characteristics and strategic plans, global trends, and the number of sales canceled or delayed.

Canceling the lease sales would result in delaying the subsequent development activities that would take place. Revenues collected by the Federal Government (and thus revenue disbursements to the States) would be adversely affected by such a delay because of the "time value of money" (i.e., a dollar received in the future is valued less than the same dollar received today because of the opportunity to earn interest). Canceling lease sales would delay the receipt of interest on billions of dollars of bonus bids, rental income, and royalty income by the Federal treasury.

Hydrocarbon Use

An energy policy is the utilization and mixture of energy types deployed to meet national requirements for transportation fuels (i.e., diesel, jet fuel, kerosene, gasoline, and even compressed natural gas), electricity generation, and space heating, and the degree to which a country seeks to place or reduce emphasis on this mix. The oil and natural gas that would have been produced as a result of all lease sales under the Five-Year Program would not be available to consumers for transportation fuels, who would therefore need to (1) obtain energy from other sources, (2) change the energy use mix, or (3) endure the economic consequences of doing without. Energy substitutes and changes in energy use mix needed to replace or adapt to lost OCS production would be associated with their own potential environmental impacts and effects that could occur in the U.S. or be displaced to other parts of the world.

The highest daily oil production rate in the GOM was 1.73 million barrels/day (MMbbl/day) in June 2002 (The Oil Drum, 2009). On January 3, 2011, Casselman and Gilbert (2011) reported that a sustained slowed permitting process in the GOM has long-term implications for U.S. oil production. The

U.S. Dept. of Energy's (DOE's) Energy Information Administration reported that domestic crude oil production in the U.S. in 2010 as 5.51 MMbbl/day (USDOE, Energy Information Administration, 2010a). The DOE's Energy Information Administration also reported that production in the GOM declined 116,400 bbl/day between 2008 and 2010 (USDOE, Energy Information Administration, 2010a) and has been in a general state of decline since 2002, as shown by **Figure G-1**. **Figure G-1** shows cumulative oil and gas production in the GOM by planning area (USDOI, BOEMRE, 2010). **Figure G-1** also shows cumulative oil and gas production in the GOM by planning area (USDOI, BOEMRE, 2010).

Other Sources of Oil and Gas

Other sources of energy may substitute for delayed or lost production from delayed or cancelled lease sales. Principal substitutes would be conservation, additional domestic production, equivalent-liquid substitutions (biofuels), or additional imports. The largest portion of our energy (over 39%) comes from liquid fuels, primarily petroleum. Natural gas adds another 23 percent (USDOE, Energy Information Administration, 2009).

As a transportation fuel, petroleum has no current substitutes for the scale at which this country uses it. The DOE's Energy Information Administration reported that 3.24 billion bbl of gasoline and 552 billion bbl (Bbbl) of distillate fuel oil (diesel) were consumed in 2010 (USDOE, Energy Information Administration, 2010b). Petroleum accounted for 519 MMbbl of kerosene-style jet fuel and 5.3 MMbbl of general aviation gas in 2010.

Nearly three-fourths of all petroleum consumed is used for transportation—with natural gas, electricity, and other alternatives playing much smaller roles. Net imports of petroleum in 2009 were 3.540 Bbbl. Of a total 2.626 Bbbl of domestic petroleum and natural gas liquids produced in 2009, 0.681 Bbbl originated offshore (includes GOM) (USDOE, Energy Information Administration, 2009). The Oil Drum (2009) showed how production in the GOM peaked in June 2002. **Figure G-2** readily shows that production in the GOM peaked in 2002 (USDOI, BOEMRE, 2010). If a delay or cancellation of lease sales contributed to a further decline in GOM exploration and production activity, then replacement sources would need to be secured by

- increased imports;
- conservation;
- increase onshore domestic production in the U.S.;
- fuel switching; or
- a combination of all four.

Conservation would be the most environmentally preferable means to increase supplies of petroleum, but the amount increased by conservation would not, by itself, increase supplies at the scales needed to maintain the current economic growth rate for total energy use in the transportation sector for more than a few years. Conservation is a contributor, but it is not a sole-source answer.

Increased onshore energy production is not a realistic source for production of petroleum in large quantities capable of replacing production in the GOM. Increased onshore production can be increased for a short period of months to a year to temporarily displace GOM production as it has in the past when GOM infrastructure has been damaged by hurricanes (The Oil Drum, 2009). There are no actions that can be taken by the U.S to greatly increase the geologic endowment of petroleum onshore, and even a highly motivated policy to discover new resources onshore would result only in incremental additions to the current inventory of known reserves. The U.S. onshore production of liquid hydrocarbon has been in an irreversible decline for decades, i.e., since 1970 in the contiguous states and since 1988 in Alaska (USDOE, Energy Information Administration, 2009).

Fuel switching or equivalent-liquid substitution of ethanol, either corn-based or cellulosic, is an option used in the U.S. and in other countries. Corn-based ethanol, from corn starch, is generated in the U.S., primarily because cellulosic ethanol production is too expensive to justify large-scale use because of the cost of producing enzymes to convert cellulose into ethanol. The term "energy balance" refers to the difference between the amount of fossil energy needed to produce a fuel and the energy the fuel contains. For every unit of energy delivered at the pump, corn ethanol requires 0.76 units of fossil energy and gasoline requires 1.22 units. Thus, the use of ethanol results in the consumption of 40 percent less fossil energy than the gasoline it replaces (Wu et al., 2006), but these claims are in dispute (Rapier, 2006).

Whether or not a given volume of ethanol is more or less energy dense than gasoline, switching to ethanol use requires a decision to rely on an import food stock as a transportation fuel. In doing so, the result may be unacceptable rises in the price of basic foods because of increased demand for agricultural land to support reliance on biofuels like ethanol. To displace 30 percent of the country's petroleum consumption by conversion to ethanol of 1 billion tons of agricultural biomass (crop residues; grains; process residues, and dedicated perennial crops) can be accomplished with relatively "modest changes in agricultural land use" (USDOE and USDA, 2005). Agriculture is relatively fuel intensive (i.e., petroleum to power machinery and equipment and manufactured fertilizers and other inputs) and would have a less favorable life-cycle cost profile than cellulosic ethanol.

Pursuing additional imported petroleum is the only reliable means to add new supplies to replace a decline in GOM production of hydrocarbons used for transportation fuels. The U.S. crude oil imports stood at 9.0 MMbbl per day in 2009. At current prices of approximately $87/bbl, the U.S. spends approximately $783 million per day ($286 billion/year) on imported oil. The expectation that imports would make up the majority of any shortfall in GOM production from the programmatic No Action Alternative (cancellation of all GOM lease sales for 5 years) that was reported in the previous Five-Year Program (USDOI, MMS, 2007, p. V-354) is largely unchanged (**Table G-1**). **Table G-1** was taken from an analysis contained in the 2007-2012 Five-Year Program EIS (USDOI, MMS, 2007, Table IV-27) that originated in King (2001; Table 4). **Table G-1** was constructed for the nationwide Five-Year Program at that time and a breakout for just the GOM is not available. However, if lease sales in the GOM were cancelled for 5 years, the amount the U.S. spends on imported oil would likely exceed the current estimated $783 million/day ($286 billion/year) to replace lost GOM production.

With respect to imports replacing domestic production, forecasts have been made that peak oil production was reached by non-OPEC countries in 2004 and by the rest of the word in 2005 (Murray, 2010), in which case declines in GOM production would be sought from an ever smaller amount of petroleum available to all. Increased imports displace the environmental impacts for that production to other parts of the world. Reliance on increased importation of oil from overseas increases the spill risk for transported petroleum. The U.S. Coast Guard maintains statistics for reported spill quantities associated with transportation by tank ship and tank barge, as well as spill risk associated with production facilities and pipelines. The reported spill quantities in the U.S. and its territorial waters indicate a slightly elevated risk for petroleum transported over water vs. petroleum produced and transported by pipeline (**Figure G-2**). If imported petroleum originated from a contiguous country, such as Canada (e.g., the ambitious 2,673-kilometer [1,661-mile] long Keystone pipeline from Hardisty, Alberta, Canada, to Port Arthur, Texas (TransCanada Corporation, 2011)) or Mexico, the ship transport risk would be replaced by the petroleum transported to the Gulf region for refining by pipeline(s) from these countries or by overland transportation by rail and highway tanker.

Energy Use Mix for Transportation Fuels

Changing the energy use mix for transportation fuels presents fundamental issues to the U.S. economy that has adapted to a reliable and affordable supply of conventional oil and gas. Substitution away from fossil fuels within the proposed action scenario period could occur through shift toward (1) more efficient vehicles, (2) greater use of public transportation, or (3) use of alternative fuels that are not equivalent liquids.

An emphasis on more efficient vehicles typically focuses on trying to realize more energy from a quantity of fuel. New Corporate Average Fuel Economy standards, recently enacted by the Obama Administration, boost the fuel economy of cars and light-duty trucks sold in the U.S. to 54.5 miles per gallon by 2025 (Environmental News Service, 2011). Actualizing this goal more than doubles the current Corporate Average Fuel Economy standard of 24.1 miles per gallon. By 2025 the new standard is expected to reduce oil consumption by 0.803 Bbbl per year (2.2 MMbbl/day x 365 days) (Environmental News Service, 2011) out of the yearly consumption of 3.223 billion bbl in 2009 (USDOE, Energy Information Administration, 2009).

An emphasis on the greater use of public transportation typically focuses on building and using efficient rail transportation in high-density traffic corridors and along routes frequented by commuters and business or on enticing people to use bus or light rail systems that may have built-in alternative fuels, such as buses that run on compressed natural gas. Although the Obama Administration has ambitious goals for high-speed rail (Hinds, 2011), there appears to be at least some resistance accepting public financing incentives in areas targeted for high-speed rail because of a fear of high operating and overhead costs in the future (Jones, 2011).

An emphasis on alternatives fuels centers on the use of (1) hybrid gas-electric vehicles, (2) all electric vehicles, (3) hydrogen fuel cell vehicles, and (4) vehicles using compressed natural gas.

Hybrids use a combination power plant that is alternately gasoline and electric depending on driving conditions. As a class they are already fairly widespread and familiar to consumers, with many manufacturers offering hybrid vehicle product lines. Tax credits for people who buy them are an important stimulant. The batteries available for hybrid vehicles, as well as all-electric vehicles, face significant physico-chemical barriers for batteries as a partial or sole power source. Batteries are heavy, bulky, expensive, and have a limited lifetime of from 5 to 7 years depending on driving conditions, after which they need to be replaced. Both plug-in hybrids and electric vehicles currently use lithium-ion batteries. Gas-electric hybrid vehicles use nickel-metal hydride technology, but they are expected to switch over to lithium-ion batteries in future. Within the broad characterization of lithium-ion batteries, there are several different subtypes, each of which can be evaluated on six basic criteria: energy storage capacity; power; safety; performance; life span; and cost. Significantly, none of the battery types currently in use perform well across all six criteria. Absent a major breakthrough, fully electric vehicles that are as convenient as conventional gasoline vehicles will likely not be available before 2020 (The Boston Consulting Group, 2010).

Hydrogen-powered fuel cell vehicles also face significant physico-chemical barriers to being a practical alternative to conventional-fuel vehicles. All of the technology needed for hydrogen-powered, fuel cell-operated cars is already in existence, but not at a stage that would permit cost-effective and widespread commercial deployment. Fuel cells require hydrogen as the power source and hydrogen, as a fuel for mass transit, faces a large hurdle. Current industrial-scale hydrogen generation relies on reformulation of petroleum liquids or gases containing hydrogen atoms. Typically, the feedstock is natural gas (methane) reformulated by steam, or water separated into its component elements of hydrogen from oxygen by hydrolysis (USDOE, 2008). Both processes require significant energy inputs to "manufacture" hydrogen. Widespread adoption of hydrogen vehicles will require enormous investments in infrastructure to make the fuel as widely available as gasoline is at present. Hydrogen-powered fuel cell vehicles have taken on the moniker of always being the "fuel of the future" because of the dual need for a new support infrastructure at scale and of the need to rely on natural gas as a feedstock for hydrogen unless a large and dedicated electrical generating capacity is built for a hydrolysis industry.

Energy Use Mix for Electrical Generation and Space Heating

Changing the energy use mix for fuels used to generate electricity and for space heating presents fundamental issues to the U.S. economy that has grown accustomed over the years to a reliable and affordable supply of conventional oil and gas. Unlike petroleum liquids as a transportation fuel, there are substitutes for oil and gas for electricity generation and space heating. Coal, nuclear, and renewable technologies (hydroelectric, geothermal, solar, wind, hydrokinetic) are technologies for generating electricity, but only coal and nuclear have a significant ability to provide for base-load capacity at economies of scale. Because of their intermittency, renewable energy tends to have the potential for accommodating peak-load capacity.

Petroleum plays a very modest role in electricity generation because of its value as a transportation fuel feedstock. The proportion of U.S. electricity generation from oil-fired power plants has been in decline since 1980 (USDOE, Energy Information Administration, 2009, Table 5.14c). For natural gas the converse is true. Gas-fueled electricity generation nearly doubled over the 10 years from 1996 to 2007 (USDOE, Energy Information Administration, 2009, Table 6.5). The electricity generation sector is second only to industrial use in terms of overall consumption of natural gas (USDOE, Energy Information Administration, 2009, Table 6.5).

Natural gas use for electrical generation is second only to coal. Its use has risen sharply in recent years, growing by an average of 13 percent annually from 2003 to 2008 (USDOE, Energy Information Administration, 2009, Table 6.5) to almost 7 trillion cubic feet (Tcf) per year in 2009. Gas tends to be advantaged in comparisons to nuclear and coal from its perception as clean burning. Much natural gas used for electrical generation is used in so-called peak plants; gas turbines that are used when demand is above normal during peak-load periods. Natural gas as a source for residential or commercial space heating has remained roughly constant since the early 1970's, between about 6 and 7 Tcf combined (USDOE, Energy Information Administration, 2009, Table 6.5). Use of gas for industrial sector applications (generating heat or steam, space heating, and as nonfuel feedstocks such as fertilizer, plastics, asphalt, and medicine) peaked in the late 1990's at about 8.5 Tcf and has since declined (USDOE, Energy Information Administration, 2009, Table 6.5).

Coal is the largest source of fuel for electrical generation in the U.S. One billion short tons were used per year in 2005 through 2008 (USDOE, Energy Information Administration, 2009, Table 7.3). Coal has the reputation of an energy source in abundant supply often phrased in context of reserves able to last hundreds of years. Based on U.S. coal consumption for 2010, the U.S. recoverable coal reserves represent enough coal to last 249 years. However, the Energy Information Administration projects in the most recent Annual Energy Outlook (April 2011) that U.S. coal consumption will increase at about 1.1 percent per year for the period 2009-2035 (USDOE, Energy Information Administration, 2010c). If that growth rate continues into the future, U.S. recoverable coal reserves would be exhausted in about 119 years if no new reserves are added. Murray (2010) reported that whenever coal reserves are updated the reserve estimates are revised downward because of better survey techniques.

There are more pessimistic projections for coal. The Energy Watch Group (2007) claimed the U.S. has reach peak coal capacity for the high-quality bituminous variety in the Appalachian and Illinois basins. Coal reserves in the western U.S. are volumetrically larger than eastern bituminous coals. Western coal is slowly replacing eastern coal, but western coals are softer bituminous and subbituminous varieties that generally have lower energy content. The Energy Watch Group (2007) reported that global coal reserve data are of poor quality, but they seem to be biased towards the high side, and that production profile projections suggest the global peak of coal production would be occurring around 2025 at a production rate about 30 percent above current production.

Nuclear power currently accounts for approximately 19 percent of base-load electrical capacity and represents another potential substitute for natural gas. Because of its constancy from long periods of continuous reactor operation, nuclear power has been considered primarily for base-load capacity. The Nuclear Regulatory Commission is in the midst of an active plant relicensing phase for existing power plants, but impetus to build new nuclear power plants has met with resistance by investment banks (Clayton, 2010). A further setback occurred when the country's strategy for the closing of the nuclear fuel cycle was upended after the Obama Administration terminated licensing procedures and defunded the country's only prospective repository site for geologic waste disposal—Yucca Mountain in Nevada (Mascaro, 2010).

Hydropower as a share of renewable energy sources has been eclipsed by biofuels since the mid-2000's. Between 2002 and 2009, hydropower generated an average of about 2.6 billion Btu per year and biofuels generated an average of about 3.2 billion Btu for the same period (USDOE, Energy Information Administration, 2009, Table 10.1). Wind energy is the fastest-growing renewable energy sector, growing from 178 to 679 billion Btu between 2005 and 2009 (75%) (USDOE, Energy Information Administration, 2009, Table 10.1). Geothermal and solar generating capacity in 2009, respectively, was 50 percent and 20 percent to that of wind, making them small but important renewable sectors. Hydrokinetic technologies use ocean current, tides, or waves. Although much discussed, these technologies have not been practically deployed to produce electricity, at scale, anywhere in the U.S. or its territorial waters.

To Do Without?

World demand for oil in the third quarter of 2010 was 88.3 MMbbl/day (Hargraves, 2010), and between 2008 and 2030, Murray (2010) reported an expectation that worldwide production would increase from 85 to 97 million bbl per day, a projection that leads to flat production on a pace to accommodate world population growth with very little margin for unexpected scarcity resulting from rapid ramp-ups in use (e.g., China's economic growth), from conflict, or from other supply disruptions. The world's ability to maintain existing production and secure new production is relatively fixed, that is, it is extremely difficult to increase oil supplies making petroleum a supply-limited market (Murray, 2010). The U.S. production is part of world production and, therefore, it has an incremental effect on prices in a tight world market, with the ability to increase production only with difficulty. Oil is fungible, meaning that supply from one point in the world equals supply in any another part. If lower U.S production occurs from the cancellation of all GOM lease sales, it will add an increment of upward pressure on prices as this production is removed from the market. The U.S. may contribute to conditions that may result in a slow economic growth rate, or even recessionary cycles, if world demand exceeds the petroleum supplies that can be brought to market.

Summary and Conclusion

The use and mixture of energy types deployed to meet transportation fuel requirements may be market driven or mandated by legislation or tax policy, but either extreme or a mixture of the two constitutes an energy policy. The programmatic No Action Alternative, to not offer any GOM lease sales in the Five-Year Program, leads to a range of economic and environmental impacts from practically no impact from cancelling one lease sale to incremental decreases in supply by cancelling one, more than one, or all consecutive lease sales. In so doing, the programmatic No Action Alternative contributes incrementally, but inexorably, to upward price pressure on oil as a transportation fuel feedstock and on natural gas as a feedstock for gas-generated electrical capacity, as well as its uses for other important products such as fertilizers, medicines, plastics, and as a feedstock for a hydrogen economy. When the price for transportation fuel is high enough, market forces may economically favor developing other energy sources for, or substitutes for, oil and gas. Prices and price spikes may motivate political imperatives to incentivize or penalize existing sources and substitutes to achieve a different use mix balance.

The BOEM's best estimate for the results of the programmatic No Action Alternative in the GOM is shown in **Table G-1.** This alternative would eliminate all environmental impacts, positive and negative, associated with a proposed action. The incremental contribution of a proposed action to cumulative effects would also be eliminated, but such effects from other activities, including past lease sales and potential future OCS Program activities, would remain. The incremental source of large oil spills changes. Large oil spills (≥1,000 bbl) that may result from a proposed action are negated by the programmatic No Action Alternative: a spill source from pipelines (50%); followed by platforms (38%); with tanker spills playing a minor role (12%); would not occur. All spills as a result of this alternative in the U.S. and its territorial waters would result from transportation of imported oil (i.e., tank ships, tank barges, or intercontinental pipelines) **(Figure G-2**) because virtually all replacement oil would be imported.

The most likely outcome for cancellation of all lease sales in the GOM under the Five-Year Program is an increase in imports to compensate for lost production (**Table G-1**). Environmental impacts from an increase in oil imports to the U.S. and the global commons includes the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);
- degradation of water quality from oil spills related to accidental discharges as a result of tanker-at-sea mishaps or collisions;
- oil spills from foreign facilities, pipeline, or local tanker-to-shore operations in preparation for large vessel transport;
- oil spills from facilities, pipelines, or tankering to U.S ports during large vessel offloading operations;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas that are part of the U.S. or the world commons; and
- increasing public concern about tanker spills.

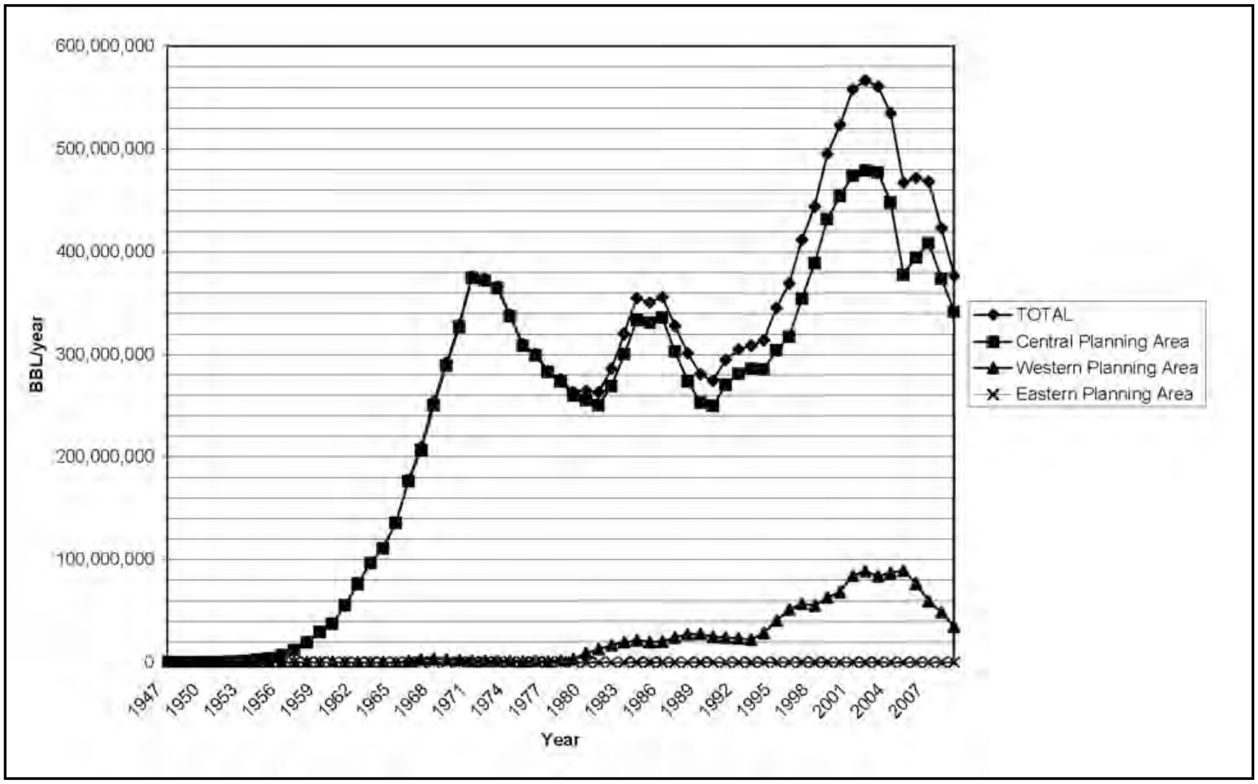

Figure G-1. Cumulative Annual Oil Production in the Gulf of Mexico by Planning Area from 1947 to 2009.

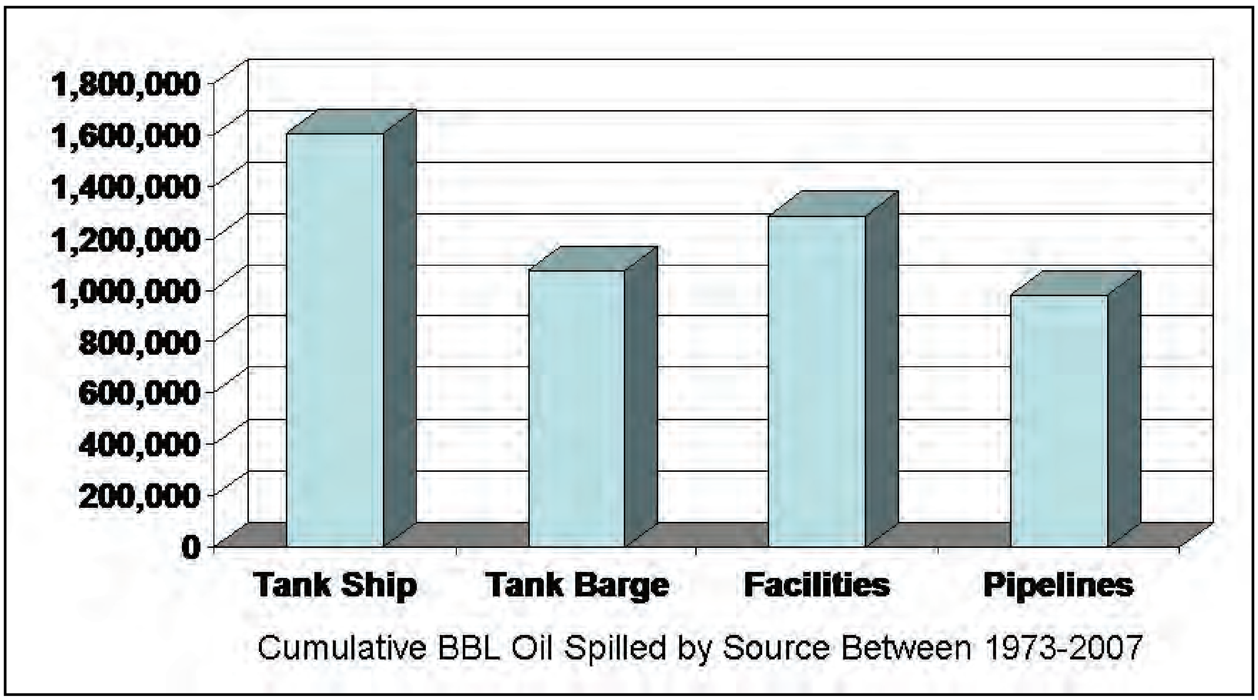

Figure G-2. Cumulative Barrels of Oil Spilled by Facilities and Pipelines and by Over-Water Transportation (Olsen, 2008).

Table G-1

BOEM's Best Estimate for the Results of the Programmatic No Action Alternative
for the Entire Five-Year Program

Sector	Percent of OCS Production		Quantity Involved	
	Low	High	Low	High
Oil				
OCS Production (BBO)	0	0	-5.5	-12.1
Onshore Production (BBO)	3	3	0.2	0.3
Imports (BBO)	88	88	5.1	10.7
Conservation (BBOE)	5	5	0.3	0.6
Switch to Gas (BBOE)	4	4	0.2	0.5
Gas				
OCS Production (Tcf)	0	0	-20.7	-36.3
Onshore Production (Tcf)	28	28	5.8	10.3
Imports (Tcf)	16	16	3.3	5.9
Conservation (Tcf)	16	16	3.4	5.8
Switch to Oil (Tcf/BBOE)	40	39	8.2/1.5	14.3/2.6

BBO = billion barrels of oil.
BBOE = billion barrels of oil equivalent.
Tcf = trillion cubic feet.

G.2. PROGRAMMATIC CUMULATIVE IMPACTS

A cumulative impact, as defined by the Council on Environmental Quality (CEQ), "results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). The analyses presented in the cumulative impacts assessment of the Five-Year Program EIS (USDOI, BOEM, 2012b) place the direct and indirect impacts of the Five-Year Program into a broader context that takes into account the full range of impacts of actions taking place within the WPA, CPA, and EPA, and the Cook Inlet, Chukchi Sea, and Beaufort Sea Planning Areas currently and into the foreseeable future. Repeated actions, even minor ones, may produce significant impacts over time through additive or interactive (synergistic) processes. The goal of the cumulative impacts assessment, therefore, is to identify such impacts early in the planning process to improve decisions and move toward more sustainable development (CEQ, 1997). The general approach for the cumulative impacts assessment follows the principles outlined by CEQ (1997) and the guidance developed by the U.S. Environmental Protection Agency (1999) for independent reviewers of environmental impact statements. It also considers the findings and recommendations of the National Environmental Policy Act (NEPA) Task Force as they pertain to programmatic assessments and environmental management systems (NEPA Task Force, 2003).

Because the Five-Year Program EIS is a programmatic-level assessment, lease-sale specific issues such as the determination of appropriate mitigation measures and environmental monitoring are not addressed there. However, the Bureau of Ocean Energy Management imposes environmental controls on operators through rules and regulations included in its lease sale proposals. Those rules and regulations include lease stipulations, mitigations, OCS regulations, Notice to Lessees and Operators, and other measures to protect the environment from the effects of lease-related activities. Environmental protection on the OCS is an ongoing priority. The Bureau of Safety and Environmental Enforcement has broad permitting and monitoring authority to ensure safe operations and environmental protection as OCS projects within a lease block are implemented.

The cumulative impacts assessment presented in the Five-Year Program EIS is the first of many such analyses that will be conducted for activities under the Five-Year Program. The NEPA reviews are required for various project phases within a lease block or portion of a lease block; these reviews will focus on the application and enforcement of mitigation measures, as well as environmental monitoring to demonstrate the effectiveness of such measures.

The cumulative impact analyses included in the Five-Year Program EIS evaluate OCS oil- and gas-related activities associated with the Five-Year Program, as well as activities associated with past Five-Year Programs and future Five-Year Programs that could occur over the next 40-50 years. The estimates for each case represent the broadest possible analysis of potential elements affecting the OCS over the next 40-50 years. Transportation and other scenario assumptions that were used in the exploration and development scenario and impact analyses also apply to the cumulative analyses.

Certain effects were deemed speculative, such as trade-off decisions by the industry, and were not considered under the cumulative cases presented here.

The effects of the No Action Alternative were also omitted from the cumulative cases of the Five-Year Program EIS, but they are analyzed in this Multisale EIS. Under a no-action scenario, there would be no lease sales conducted under the Five-Year Program in any OCS planning area. As a result, energy would be obtained from other sources to replace lost production on the OCS. Refer to **Appendix G.1** for additional information on the No Action Alternative.

The identification and evaluation of potential impacts focused on three main categories: animals, plants, and habitats. Among the animal groups evaluated were marine mammals, birds, fish, sea turtles, and benthic invertebrates. Special attention was given to migratory species, species taken commercially and for Alaska Native subsistence (including whales, other marine mammals, fish, and birds), and threatened and endangered species. With respect to habitats, both marine (e.g., corals and chemosynthetic communities) and coastal (e.g., estuaries and wetlands/marshes) areas were identified and evaluated for possible adverse impacts from OCS oil and gas activities.

Specific concerns regarding social, cultural, and economic resources included potential impacts on tourism, recreation, commercial and recreational fishing, subsistence harvests, aesthetics, local economy (especially the "boom/bust" phenomenon), land- and water-use conflicts, disproportionate impacts on low income and minority groups, and disproportionate impacts on Alaska Natives. The social, cultural, and economic topics analyzed in the Five-Year Program EIS are as follows:

- population, employment, income, and public service issues from the effects of the Five-Year Program, including issues relating to "boom/bust" economic cycles;
- land use and infrastructure, including construction of new onshore facilities, and land-use and transportation conflicts between the oil and gas activities and other uses;
- sociocultural systems effects, including concerns about the effects on subsistence resources and activities (e.g., bowhead whale hunting), loss of cultural identity, health impacts including psychological health, and social cost of oil spills;
- environmental justice (i.e., the potential for disproportionate and high adverse impacts on minority and/or low-income populations [Executive Order 12898]);
- commercial and recreational fisheries;
- tourism and recreation, including the use of coastal areas for sightseeing, wildlife observations, swimming, diving, surfing, sunbathing, berry picking and gathering roots and greens, hunting, fishing, clamming and gathering shell fish, boating, and the visual impacts of offshore OCS structures; and
- archaeological resources, including historic shipwrecks and sites inhabited by humans during prehistoric times.

The analyses in the Five-Year Program EIS describe in detail the nature and extent of potential impacts of future oil and gas activities on the OCS that may occur under a proposed action or any of the action alternatives. Specifically, the Five-Year Program EIS evaluates the potential direct, indirect, and cumulative impacts of routine operations and accidental oil spills. The analyses assume the implementation of all mitigation and other protective measures currently required by statute, regulation, or BOEM policy and practice. One objective of the Five-Year Program EIS is to convey to decisionmakers and the public the relative extent of potential impacts. Conclusions for most analyses generally indicate the ability of most affected resources to recover from impacts that could result from oil and gas development following leasing.

For further information regarding the Five-Year Program (USDOI, BOEM, 2012a) and the Five-Year Program EIS (USDOI, BOEM, 2012b) cumulative case scenarios and analyses, see BOEM's website at http://boem.gov/5-year/2012-2017. Chapter 4.6 (Cumulative Impacts) of the Five-Year Program EIS is hereby incorporated by reference.

G.3. PROGRAMMATIC CONSIDERATIONS OF CLIMATE CHANGE AND THE BASELINE ENVIRONMENT

The section numbering of the text below reflects the source document, *Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017, Final Environmental Impact Statement* (Five-Year Program EIS) (USDOI, BOEM, 2012b).

3.3. CONSIDERATIONS OF CLIMATE CHANGE AND THE BASELINE ENVIRONMENT

Several natural and anthropogenic factors affect climate variability, but scientific evidence has led to the conclusion that current climate warming trends are linked to human activities, which are predominantly associated with greenhouse gas emissions (e.g., NRC, 2010). Climate change effects have been observed to be occurring on all continents and oceans, and these observations have provided insights on relationships among atmospheric concentrations of carbon dioxide and other greenhouse gases, mean global temperature increases, and observed effects on physical and biological systems (IPCC, 2007). There are many impacts associated with climate change processes that have been observed in U.S. coastal regions that include changing air and water temperatures, rising sea levels, more intense storms, ocean acidification, coastal erosion, sea ice loss, declining coral reef conditions, and loss of critical habitats such as estuaries, wetlands, barrier islands, and mangroves (e.g., Boesch et al., 2000; ACIA, 2005; Titus et al., 2009; Morel et al., 2010; Pendleton et al., 2010; Blunden et al., 2011).

The global climate system is driven largely by incoming solar energy that is reflected, absorbed, and emitted within the Earth's atmosphere, and the resulting energy balance determines atmospheric temperatures (Solomon et al., 2007). Atmospheric concentrations of greenhouse gases (carbon dioxide, methane, nitrous oxide, and halocarbons) increase absorption and emission of energy, resulting in a positive radiative forcing to the climate system and warmer global mean temperatures; this process is often described in general terms as the greenhouse effect. Global concentrations of greenhouse gases in the atmosphere have increased from pre-industrial times and by 70% from 1970 to 2004; these emission increases are linked to human activity sectors such as energy, industry, transportation, and agriculture (IPCC, 2007; Rogner et al., 2007). The climate system response to this positive radiative forcing is complicated by a number of positive and negative feedback processes among atmospheric, terrestrial, and oceanic ecosystems, but overall the climate is warming, as is evident by observed increases in air and ocean temperatures, melting of snow and ice, and sea level rise (IPCC, 2007).

Global mean atmospheric temperatures have risen by 0.74 ± 0.18°C (1.33 ± 0.32°F) between 1905 and 2005, and the rate of warming for the past 50 yr has been almost double the rate for the past 100 yr (0.13°C [0.23°F] per decade) (Trenberth et al., 2007). Atmospheric warming has not been spatially uniform, and in particular arctic temperatures have increased about twice as much as those in lower latitudes (ACIA, 2005). Preferential warming in the Arctic is partially the result of the ice-albedo effect, which occurs when highly reflective ice is replaced by less reflective water and land surfaces, resulting in more heat being absorbed by the land and water rather than being reflected back to the atmosphere (Perovich et al., 2008). About 80% of the warmth caused by greenhouse gases has been absorbed in the oceans (NRC, 2010). Long-term observations of oceanic temperatures have revealed considerable inter-annual and inter-decadal variability. Between 1961 and 2003, oceanic warming was widespread in the upper 700 m (2,300 ft) of oceans, where the global mean ocean temperature has risen by 0.10°C (0.18°F) (Bindoff et al., 2007).

The effects of climate change on ecosystems are complex and nonuniform across the globe and vary among atmospheric, terrestrial, and oceanic systems (e.g., IPCC, 2007; Blunden et al., 2011). Considerations of climate change effects in OCS planning areas focus on impacts on marine and coastal systems where environmental sensitivities are typically associated with increasing atmospheric and ocean temperatures, but they can also be categorized as responses to sea level rise, coastal erosion, and ocean acidification. These general categories of climate change responses are occurring in addition to human-induced pressures related to coastal population densities (e.g., land use changes, pollution, overfishing) and trends of increasing human use of coastal areas (Nicholls et al., 2007).

Environmental Sensitivity to Atmospheric and Oceanic Temperature Increases. Environmental responses to warming atmospheric and oceanic temperatures include changes to species composition, coral reef damage, permafrost thawing, increased occurrences of storm events, coastal erosion, loss of sea ice, and changes in ocean dynamics.

Species Composition. Effects of warming temperatures have already been seen in the form of changes in species location ranges, changes in migration patterns and timing, changes in location and timing of reproduction, and increases in disease (Perry et al., 2005; Rosenzweig et al., 2007; Simmonds and Isaac, 2007). As species extend their spatial ranges, there can be negative consequences related to non-native and invasive species (Twilley et al., 2001). Climate change impacts on aquatic environments have the potential to affect species composition within an ecosystem according to species-specific thresholds, as well as species characteristics such as mobility, lifespan, and availability to use available resources (e.g., Chapin et al., 2000; Levinsky et al., 2007). These variations in species-specific thresholds and characteristics result in the breakup of existing ecosystems and the formation of new ones in response to climate change, with unknown consequences (Perry et al., 2005; Simmonds and Isaac, 2007; Karl et al., 2009).

Coral Reef Damage. Warmer water temperatures or increases in ultraviolet light penetration cause coral to lose their symbiotic algae, a process called bleaching. Intensities and frequencies of bleaching events have increased substantially over the past 30 yr, resulting in the death of or severe damage to about one third of the world's shallow water corals (Karl et al., 2009). In addition to coral bleaching, there has been a rise in the occurrence of excessive algal growth on reefs, as well as the presence of predatory organisms and reports of diseases related to bacterial, fungal, and viral agents (Boesch et al., 2000; Twilley et al., 2001). Additional discussion of coral reef damage is presented in Section 3.7.2.1.7.

Permafrost Thawing. Permafrost degradation affects terrestrial and hydrologic conditions in Arctic regions where the temperature at the top of the permafrost layer has increased by up to 3°C (5.4°F) since the 1980s, and in the Alaskan Arctic the permafrost base has been thawing at a rate of up to 0.04 m/yr (0.13 ft/yr) (Lemke et al., 2007). Recent data collected in 2010 suggest that trends in permafrost warming have begun to propagate southward nearly 200 km (124 mi) inland from the North Slope region (Richter-Menge and Jeffries, 2011).

Thawing of permafrost near coastal regions is expected to result in more rapid rates of shore erosion, increases in stored-carbon releases (Schuur et al., 2009), and damage to infrastructure such as roads and pipelines (Karl et al., 2009). These effects are expected to be compounded by reduced duration and extent of shoreline protection provided by landfast ice and more exposure to ocean storms.

Increases in Major Storm Frequency and Intensity. Regional weather conditions are influenced by modal climatic variability patterns such as the El Niño-Southern Oscillation (ENSO), Arctic Oscillation (AO), North Atlantic Oscillation (NAO), and the Pacific Decadal Oscillation (PDO) that act as connection pathways between regional atmospheric conditions and the world's oceans (NRC, 1998; Liu and Alexander, 2007). Major storms in low- to mid-latitude regions (e.g., cyclones, hurricanes, and typhoons) are largely controlled by the ENSO phase (Trenberth et al., 2007). In the northern hemisphere, there is a general northward shift in cyclone activity that is correlated with AO and NAO phases (ACIA, 2005). Climate change affects water temperatures and wind patterns that interact to either enhance or work against storm formation, making it difficult to predict climate change effects on major storm events (Karl et al., 2009). However, a number of studies have concluded that cyclonic activity has changed over the second half of the 20th century with evidence suggesting that since the 1970s there has been a substantial upward trend toward longer-lasting and more intense storms (Trenberth et al., 2007).

Sea Ice Biome. The presence of sea ice and landfast ice in the marine environment of the Arctic creates a productive marine ice biome essential for the survival and flourishing of marine animals and supports traditional subsistence communities (e.g., Berkes and Jolly, 2001; Simmonds and Isaac, 2007; Arp et al., 2010). These environments provide hunting, resting, and birthing platforms along the ice-water interface, generate local upwelling responsible for high productivity in polynyas, and release large quantities of algae growing beneath the ice surface into the food chain at ice melt (ACIA, 2005). Polar bear populations are strongly correlated with regional characteristics of sea ice and vary seasonally and with respect to specific requirements for reproduction (Durner et al., 2004). The Iñupiat Eskimos, Alaska Native people of coastal villages of northwestern Alaska and the North Slope, use sea ice for hunting and fishing grounds, as well as seasonal whaling camps that are vital to support their subsistence lifestyle (Braund and Kruse, 2009). The greatest threat to the sea ice biome is the loss of sea ice due to climate change. Sea ice extent, as observed mainly by remote sensing methods, has decreased at a rate of approximately 3% per decade starting in the 1970s with larger decreases occurring in summer months (Parkinson, 2000). Multi-year sea ice has decreased at a rate of nearly 9 to 12% per decade since the 1980s (Comiso, 2002; Perovich et al., 2010), but more recent studies have shown a loss of multi-year ice area of 42% from 2005 to 2008 (Kwok and Cunningham, 2010).

Ocean Dynamics. While large-scale trends in ocean salinity suggest certain regions have been experiencing changes in salinity that in combination with the warming of the atmosphere and oceans can change the dynamic properties of the ocean circulation patterns, there is currently no clear evidence for suggesting significant changes to major ocean circulation patterns as a result of climate change (Bindoff et al., 2007). However, there have been more regional studies that have suggested potential mechanistic changes to ocean circulations. For example, Bakun (1990) presented evidence on the effects of altered wind patterns that could enhance coastal upwelling along the western coast of the United States, which could increase productivity in these regions as nutrient-rich bottom water ascends to the ocean surface. There has also been interest in understanding the effect of increased freshwater inputs from the Greenland Ice Sheet on overturning the North Atlantic Current (Church, 2007; Rabe et al., 2011). One of the largest obstacles for understanding climate change effects on ocean currents is the lack of long-term measurements, which makes it difficult to decipher climate change responses from inter-decadal variability (Bryden et al., 2003).

Environmental Sensitivity to Sea Level Rise and Coastal Erosion. The recent global sea level rise has been caused by warming-induced thermal expansion of the oceans and accelerated melting of glaciers and ice sheets. The global mean sea level has risen at a mean rate of 1.8 ± 0.5 mm/yr from 1961 to 2003 with considerable variability spatially, as well as considerable decadal time-scale variability (Bindoff et al., 2007). Predictions in sea level rise are as much as 0.6 m (2 ft) by 2100 (Nicholls et al., 2007). The amount of relative sea level rise along different parts of the U.S. coast depends not only on thermal expansion and ice sheet melting, but also on the changes in elevation of the land that occur as a result of subsidence or geologic uplift (Karl et al., 2009). Submergence hotspots can occur as a result of local subsidence in combination with sea level rise such that the rate of rise of sea level relative to the land is expected to be higher than in other parts of the area.

Certain areas along the Atlantic and GOM coasts are undergoing relatively rapid inundation and landscape changes because of the prevalence of low-lying coastal lands (Titus et al., 2009). Barrier islands in the northern GOM have been losing land areas and changing habitat conditions because of decreased sediment supplies from rivers, sea level rise, and intense storms (Lucas and Carter, 2010). Coastal erosion rates over the past couple of decades averaged 3.7 m/yr (12 ft/yr), but storm events such as Hurricane Rita have caused erosion rates of 12 to 15 m (39 to 49 ft) in a single event (Park and Edge, 2011). The coasts of the Beaufort and Chukchi Seas consist of river deltas, barrier islands, exposed bluffs, and large inlets and inland are characterized by low-relief lands underlain by permafrost (Jorgenson and Brown, 2005). The combination of wind-driven waves, river erosion, sea level rise, and sea ice scour with highly erodible coastal lands creates the potential for high erosion rates along the Beaufort and Chukchi Sea coasts (Proshutinsky et al., 2001; Mars and Houseknecht, 2007). In addition to coastal erosion along the arctic coast, storm surge flooding has converted freshwater lakes into estuaries, affecting habitat conditions (Arp et al., 2010).

Environmental Sensitivity to Ocean Acidification. Ocean acidification refers to the decrease in the pH of the oceans and its buffering capacity caused by the uptake of carbon dioxide from the atmosphere that reacts with seawater to form carbonic acid, leading to decreasing pH values in the oceans. Predictions of future ocean water pH levels vary somewhat, but predicted decreases range from 0.14 to 0.4 pH units over the 21st century (Caldeira and Wickett, 2005; Orr et al., 2005; IPCC, 2007). Factors such as water temperatures, salinity, sea ice, and ocean mixing processes affect the amount of carbon dioxide absorbed by oceans, so climate change effects on storms, river discharge, and precipitation patterns all affect ocean acidification (IPCC, 2007). The mechanisms that lead to ocean acidification also affect estuarine and coastal waters, although their impacts on estuarine ecosystems are not well known because of the multitude of processes affecting pH levels in these systems (Feely et al., 2010).

Ocean acidification affects the ability of certain organisms to create shells or skeletons by calcification, which can be especially harmful to mollusks, corals, and certain plankton species that are important to oceanic food chains (Orr et al., 2005; Karl et al., 2009). However, several laboratory experiments conducted under elevated carbon dioxide conditions have shown mixed calcification rates in many organisms (including positive responses to ocean acidification), which suggests complex mechanisms by which organisms respond to ocean acidification (Doney et al., 2009; Ries et al., 2009). Coral reefs are highly dependent on calcified structures for survival and both warm-water and cold-water corals are negatively impacted by ocean acidification (Royal Society, 2005). Ocean waters in Arctic regions are highly susceptible to ocean acidification resulting from increased carbon dioxide solubility, freshwater inputs, and increased primary productivity, and these factors relating to ocean acidification are enhanced by current climate change trends and loss of sea ice (Fabry et al., 2009; Steinacher et al., 2009).

Climate Change Predictions and Uncertainties. Climate change predictions are based on a variety of models that simulate all relevant physical processes affecting interactions among the atmosphere, oceans, and biosphere, which are driven by a variety of projected greenhouse gas emission scenarios. Global climate models generate projected changes in atmospheric, ocean, and land surface climate variables at scales on the order of one degree in latitude and longitude, which are not sufficient for making regional-scale climate assessments. Downscaling global climate models and coupling them with more localized regional climate models is an active area of current research (Christensen et al., 2007; Randall et al., 2007). The complexity of modeling global and regional climate systems is great, so it is important to consider measures of uncertainty, which is typically done using a multi-model ensemble approach (Krishnamurti et al., 2000). It is important to recognize that despite new climate model developments, uncertainty in climate projections can never be entirely eliminated (McWilliams, 2007).

The Intergovernmental Panel on Climate Change (IPCC) has summarized climate change predictions over the next two decades and over the 21st century, using climate model predictions and evidence from various scientific disciplines (IPCC, 2007). The IPCC uses a 10-fold likelihood scale ranging from virtually certain (>99% probability of occurrence) to exceptionally unlikely (<1% probability) to define consistent terminology for climate change projections where uncertainty can be assessed by statistical analyses, and a 10-point scale (10 being the most confident) for projections where uncertainty was qualitatively assessed by expert judgment. The most recent climate change projections summarized by the IPCC (2007) include some of the following:

- An increase in atmospheric temperatures of approximately 0.2°C (0.4°F) per decade is predicted over a range in projected greenhouse gas emission scenarios;
- Warming is expected to be greatest over land and at higher latitudes;
- Model estimates of sea level rise vary from 0.18 to 0.59 m (0.6 to 2 ft) by the end of the 21st century, but information on important feedback processes to sea level rise do not allow for determining a best estimate;
- Polar regions are projected to have continued reductions in sea ice, glaciers, and ice sheets;
- Projection models suggest that ocean pH values decreasing between 0.14 and 0.35 over the 21^{st} century;
- It is likely (>66%) that tropical cyclones will become more intense;
- Increased precipitation is very likely (>90%) to occur at high-latitudes;
- There is high confidence (8 out of 10) that annual river runoff will increase by 10 to 40% at high latitudes and decrease by 10 to 30% in dry regions of mid-latitudes;
- Net carbon uptake by terrestrial ecosystems is likely (>66%) to peak during this century as natural carbon sequestration mechanisms reach their capacity; and
- There is medium confidence (5 out of 10) that predicted temperature increases will result in approximately 20 to 30% of plant and animal species that have been assessed likely (>60%) being at an increased risk of extinction.

3.3.1. Gulf of Mexico

Climate change in the GOM is expected to affect coastal ecosystems, forests, air and water quality, fisheries, and business sectors such as industry and energy (Ning et al., 2003). The GOM region has experienced increasing atmospheric temperatures since the 1960s, and from 1900 to 1991 sea surface temperatures have increased in coastal areas and decreased in offshore regions (Twilley et al., 2001). In addition to temperature changes, the northern coast of the GOM is experiencing impacts associated with sea level rise that include the loss of coastal wetland and mangrove habitats, salt water intrusion into coastal aquifers and forests, and increases in shoreline erosion (Williams et al., 1999; Pendleton et al., 2010). Climate change associated sea level rise is occurring in combination with altered hydrology and land subsidence that has resulted in measures of relative sea level rise ranging between 0.002 m/yr (0.007 ft/yr) along Texas and up to 0.01 m/yr (0.03 ft/yr) along the Mississippi River Delta (Twilley et al., 2001).

Climate models generally predict a rise in temperatures in the GOM Coastal States this century; however, predictions of precipitation are more problematic due to model uncertainties (Karl et al., 2009). Predictions of precipitation among various modeling studies for the GOM region have generally predicted a slight decrease in precipitation in coastal areas, as well as more intense rainfall events and longer periods of drought, but models vary widely in upland areas, which affect river discharges (Mulholland et al., 1997; Boesch et al., 2000; Twilley et al., 2001).

Significant increases or decreases in precipitation and river runoff would affect salinity and water circulation, as well as water quality. Increased runoff would likely deliver increased amounts of nutrients (such as nitrogen and phosphorous) to estuaries, increase the stratification between warmer fresher and colder saltier water, and potentially lead to eutrophication of estuaries and increase the potential for harmful algal blooms that can deplete oxygen levels (Justic et al., 1996; Karl et al., 2009). Reductions of freshwater flows in rivers or prolonged drought periods could substantially reduce biological productivity in Mobile Bay, Apalachicola Bay, Tampa Bay, and the lagoons of Texas and could increase the salinity in coastal ecosystems, resulting in a decline in mangrove and sea grass habitats (Twilley et al., 2001).

Decreased runoff could also diminish flushing of the estuaries, decrease the size of estuarine nursery zones, and allow an increase in predators and pathogens (Boesch et al., 2000).

Sea level rise along parts of the northern GOM coast are as high as 0.01 m/yr (0.03 ft/yr), which is much greater than globally averaged rates (Twilley et al., 2001; IPCC, 2007). The combination of sea level rise and land subsidence is resulting in the loss of coastal wetlands and mangroves, which is damaging to habitat functions to many important fish and shellfish populations. Future sea level rise is expected to cause additional saltwater intrusion into coastal aquifers of the GOM, potentially making some unsuitable as potable water supplies (Karl et al., 2009). Saltwater intrusion and sea level rise are damaging coastal bottomland forests (primarily along the western GOM coast) and mangroves through soil salinity poisoning, increased hydroperiods, and coastal erosion (Williams et al., 1999). Additionally, climate change model predictions suggest that there will be an increase in the intensity of hurricanes (IPCC, 2007), and coastal regions may potentially have fewer barrier islands, coastal wetlands, and mangrove forests to buffer the resulting storm surges as a result of sea level rise.

Marine biota in the GOM are influenced by changes in temperature, salinity, and ocean acidification, as well as their biological environment including predators, prey, species interactions, disease, and fishing pressure (Karl et al., 2009). Projected changes in physical oceanographic conditions can affect the growth, survival, reproduction, and spatial distribution of marine fish species and of the prey, competitors, and predators that influence the dynamics of these species. However, impacts on marine biota associated with climate change need to be considered against natural variation (Rosenzweig et al., 2007).

For further information regarding the Five-Year Program (USDOI, BOEM, 2012a) and the Five-Year Program EIS (USDOI, BOEM, 2012b) discussion on Considerations of Climate Change and the Baseline Environment, see BOEM's website at http://boem.gov/5-year/2012-2017. Chapter 3.3 ("Considerations of Climate Change and the Baseline Environment") of the Five-Year Program EIS is hereby incorporated by reference.

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APPENDIX H

RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO OCS REGION, 2006–PRESENT

APPENDIX H. RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO OCS REGION, 2006–PRESENT

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*
MMS 2008-009	*Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico: Interim Report 1*
MMS 2008-012	*Proceedings: Twenty-Fourth Gulf of Mexico Information Transfer Meeting, January 2007*
MMS 2008-015	*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.
MMS 2008-017	*Examination of the Development of Liquefied Natural Gas on the Gulf of Mexico*
MMS 2008-018	*Viosca Knoll Wreck: Discovery and Investigation of an Early Nineteenth-Century Wooden Sailing Vessel in 2,000 Feet of Water*
MMS 2008-019	*Post-Hurricane Assessment at the East Flower Garden Bank Long-Term Monitoring Site: November 2005*
MMS 2008-022	*Effects of Subsea Processing on Deepwater Environments in the Gulf of Mexico*
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*
MMS 2008-029	*Five-Year Meteorological Datasets for CALMET/CALPUFF and OCD5 Modeling of the Gulf of Mexico Region*
 MMS 2008-030 MMS 2008-031	*Study of Deepwater Currents in the Northwestern Gulf of Mexico* *Volume I: Executive Summary* *Volume II: Technical Report*

 MMS 2008-042 MMS 2008-043 MMS 2008-044 MMS 2008-045 MMS 2008-046 MMS 2008-047	*History of the Offshore Oil and Gas Industry in Southern Louisiana* *Volume I: Papers on the Evolving Offshore Industry* *Volume II: Bayou Lafourche—Oral Histories of the Oil and Gas Industry* *Volume III: Morgan City's History in the Era of Oil and Gas—Perspectives of Those Who Were There* *Volume IV: Terrebonne Parish* *Volume V: Guide to the Interviews* *Volume VI: A Collection of Photographs*
MMS 2008-048	*Platform Debris Fields Associated with the Blue Dolphin (Buccaneer) Gas and Oil Field Artificial Reef Sites Offshore Freeport, Texas: Extent, Composition, and Biological Utilization*
 MMS 2008-050 MMS 2008-051	*Labor Needs Survey* *Volume I: Technical Report* *Volume II: Survey Instruments*
MMS 2008-052	*Benefits and Burdens of OCS Activities on States, Labor Market Areas, Coastal Counties, and Selected Communities*
MMS 2008-058	*Cumulative Increment Analysis for the Breton National Wilderness Area*
Published in 2007	
Study Number	Title
MMS 2007-015	*Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico; Artificial Reef Effect in Deepwater*
MMS 2007-019	*Mixtures of Metals and Polynuclear Aromatic Hydrocarbons May Elicit Complex, Nonadditive Toxicological Interactions*
MMS 2007-022	*Full-Water Column Current Observations in the Central Gulf of Mexico: Final Report*
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*
MMS 2006-063	*Economic Effects of Petroleum Prices and Production in the Gulf of Mexico OCS on the U.S. Gulf Coast Economy*
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*

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

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.